PROCEEDINGS *of the* HAWAIIAN ENTOMOLOGICAL SOCIETY *for* 1957

VOL. XVI, No. 3
JULY, 1958

Suggestions for Manuscripts

Manuscripts should be typewritten on one side of standard-size white bond paper, double or triple spaced, with ample margins. The sheets should not be fastened together; they should be mailed flat. Pages should be numbered consecutively. Inserts should be typed on separate pages and placed in the manuscript in the proper sequence.

Footnotes should be numbered consecutively and inserted in the manuscript immediately below the citation, separated from the text by lines. They should be used only where necessary.

All names and references should be checked for accuracy, including diacritical marks. Authors' names must be spelled out when first mentioned.

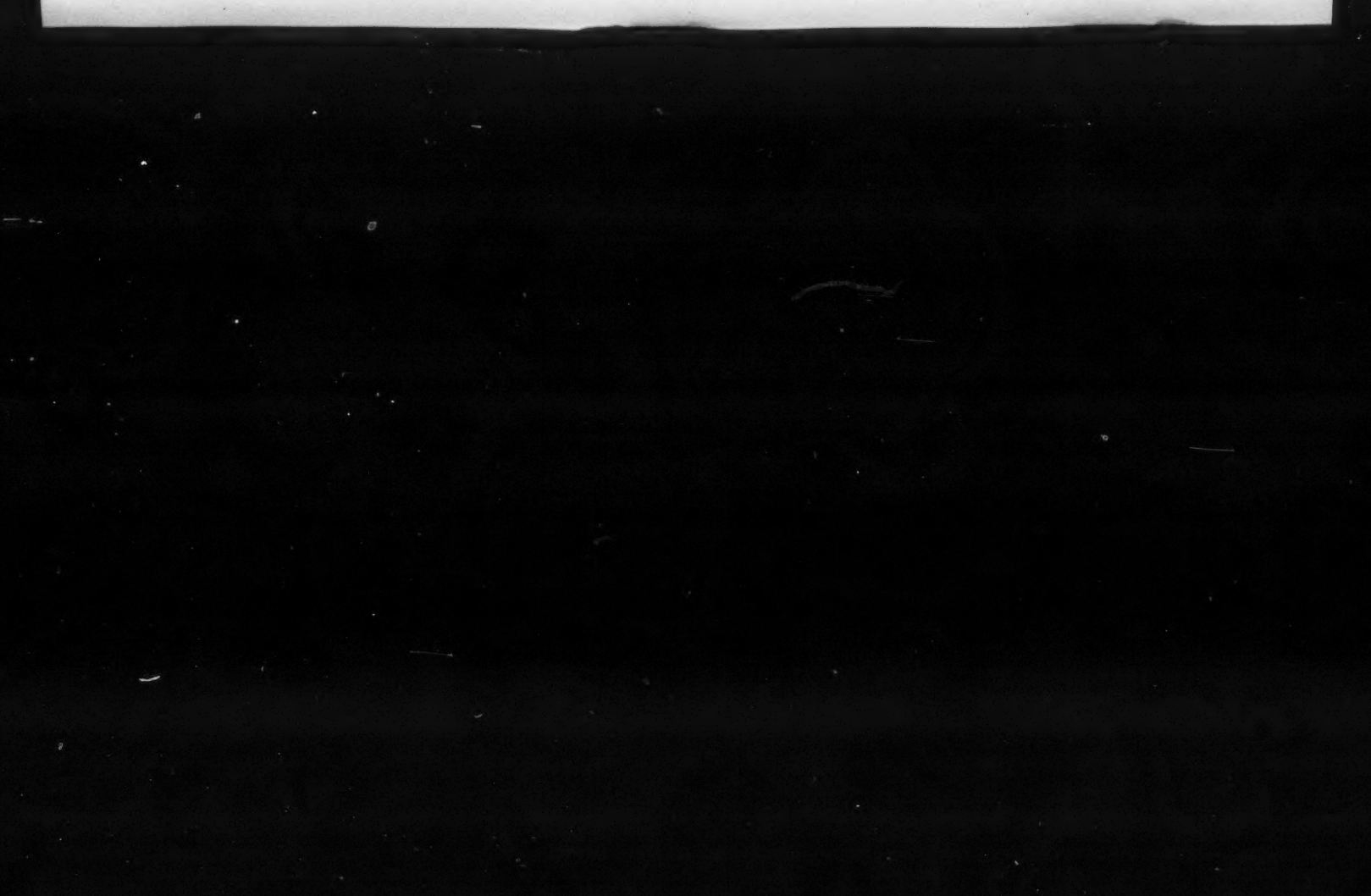
Illustrations should be planned to fit the type page, 4½ x 7 inches. They should be drawn to allow for at least one-third reduction. Each should be labeled on the back with the author's name and title of the paper, as well as the number of the figure referred to in the text. Where size or magnification is important, some indication of scale should be given. They should be numbered consecutively, using capital letters to indicate parts of a composite figure. Printed letters are available from the Secretary. Legends should be typed on a separate sheet of paper and identified by the figure number.

Tables and graphs should be used only where necessary and omitted if essentially the same information is given in the paper. Graphs and figures should be drawn in India ink on white paper, tracing cloth, or light blue cross-hatched paper.

Proofs should be corrected as soon as received and returned to the editor with the abstract on forms provided. Additional costs to the Society for correction of authors' changes in proofs may be charged to authors. An order for reprints should be placed when proofs are returned.

Fifty gratis copies of reprints will be supplied by the Society to authors under certain circumstances. The Secretary should be consulted on this point.

Examination of articles in this issue will help in conforming to the style of presentation desired.



PROCEEDINGS
of the
Hawaiian Entomological Society

VOL. XVI, NO. 3 FOR THE YEAR 1957 JULY, 1958

JANUARY 14, 1957

The 613th meeting convened at the Experiment Station, H.S.P.A., at 2:00 P.M. on Monday, January 14, 1957, with President-elect Tuthill presiding.

Members present: Adachi, Awai, Balock, Barker, Beardsley, Bess, Bianchi, Boyle, Carter, Chilson, Chock, Chong, Gressitt, Hardy, Holway, Ito, Joyce, Kamasaki, Keck, Keiser, Look, Macdougall, Maeda, Maehler, Mitchell, Miyake, Nakata, Namba, Nishida, Ota, Pemberton, D. Rainwater, Rosa, Sakimura, Steiner, Suehiro, Tuthill, Weber, Woolford, and Yoshimoto.

Visitors: John R. Einmo, James R. Holloway, and James Y. Kim.

Mr. John R. Einmo was elected to membership in the Society.

A constitutional amendment proposed at the meeting of November 13, 1956, was adopted. This amendment replaces paragraph 4 of Section 2, Article 5, with the following: "Vacancies occurring among elective offices of the Society shall be filled by the Executive Committee, subject to approval by the membership."

Dr. Hardy showed a most interesting sound-and-color motion picture entitled "The Rival World" and issued by the Shell Chemical Company.

NOTES AND EXHIBITIONS

ARAECERUS VIEILLARDI (Montrouzier): Dr. Nishida reported damage by this anthribid beetle to passion fruit, *Passiflora edulis* f. *flavicarpa* Degener. During July of 1956 many mature green passion fruits were found dropping to the ground on the University of Hawaii Experimental Farm at Waimanalo, Oahu. The peduncles of these fruits were being damaged by small coleopterous larvae found under the dried calyx and corolla, which remain on the peduncle until the fruit is fully grown. When the peduncles were cut off and placed in rearing jars, adults of *A. vieillardi* emerged. Although the beetle is known to feed on a large number of plants, this appears to be the first ob-

served case of its damaging passion fruits. Specimens were identified by Miss Rose Ella Warner of the U. S. Department of Agriculture.

HUNGARIAN ENTOMOLOGISTS: Dr. Gressitt provided interesting notes on two Hungarian entomologists who were out of Hungary when the recent uprisings began there. Dr. Paul Surany, who is doing research on the coconut rhinoceros beetle in Ceylon for the South Pacific Commission through a Rockefeller Foundation grant, has not heard from his parents in Hungary since the trouble started. However, Dr. J. J. H. Szent-Ivany, who is working in the Australia-New Guinea area, reports that his wife and daughter have escaped from Hungary. These two men recently spent time together in Ceylon, Java, and Singapore.

Mr. Beardsley presented notes on the following four species and exhibited specimens:

DIVERSINERVUS ELEGANS Silvestri: Specimens of this encyrtid wasp, previously unrecorded in the Territory, were reared from *Saissetia nigra* (Nietner) collected on hibiscus at Pearl Harbor, Oahu, during December 1956 by C. F. Clagg. The determination was made by Messrs. Timberlake and Compere at the University of California Citrus Experiment Station, and the taxonomy and biology of *elegans* have been treated by Compere (UNIV. CALIF. PUBS. ENT. 5(11):233–245, 1931). Compere found it to be a primary parasite of *Saissetia oleae* (Bernard), the black scale. It has previously been known from Africa and Queensland, Australia.

HABROLEPIS ROUXI Compere: Several specimens of this encyrtid wasp, first found in the Territory during 1956, were collected on a scale-infested citrus tree at Waipio, Oahu, during January. One wasp was reared from *Chrysomphalus ficus* Ashmead, and this is the first host record for the wasp in Hawaii. It has been reared from *Aonidiella aurantii* (Maskell) on citrus in California.

HELIOTHIS VIRESCENS (Fabricius): Adults of the tobacco budworm were reared from larvae found feeding on blossoms of the Chinese preserving melon, *Benincasa hispida* (Thunb.) Cogn., which apparently constitutes a new host record for this recent immigrant phalaenid moth.

ORTHOTYLUS PERKINSI Kirkaldy: A series of this mirid bug was taken at about 2000 feet elevation at Kawela, Molokai, December 13, 1956, on *Sophora chrysophylla* (Salisb.) Seem. Neither the mirid nor its leguminous host plant has been reported previously from Molokai, although they are known from the other main islands of the Hawaiian group.

EIDOLEON WILSONI (McLachlan): Mr. Bianchi reported that he and Mr. Beardsley had found adults of this myrmeleonid fairly abundant on December 12 and 14, 1956, at Kawela, Molokai, on a rocky eroded slope from sea level to about 600 feet elevation. This is a new Molokai record, as the species

has been previously reported only from Hawaii and Lanai. However, another species, *E. perjurus perjurus* (Walker), is known from Molokai, as well as from Oahu.

LAPHYGMA EXEMPTA (Walker): Mr. Bianchi stated that he and Mr. Beardsley had found the nutgrass armyworm quite abundant in a grassy area a few feet above sea level at Kawela, Molokai, on December 12 and 14, 1956. The case is noteworthy because during the last few years such infestations have become uncommon on most of our islands, particularly Oahu, due presumably to the establishment of a number of parasites introduced from Texas in 1942–1943. Of these parasites, *Meteorus laphygmae* Viereck, *Apanteles marginiventris* (Cresson), and *Achaetoneura archippivora* Williston were either collected on Molokai by Bianchi and Beardsley or reared by them from caterpillars collected there.

PARATRIGONIDIUM ATROFERRUGINEUM Brunner: Mr. Bianchi reported collecting many of these crickets at an elevation of 1000 or 1200 feet at Kawela, Molokai. The species is endemic to that island and the collection is noteworthy only in that the crickets were more abundant than is usually the case. As usual, they were to be found exclusively on one form of the tree host, *Metrosideros collina polymorpha* (Gaud.) Rock, although other forms were in some cases immediately adjacent. The color of the leaves in the preferred form is such that it is extremely difficult to see the crickets among them, which would not be the case with other forms of the tree.

Mr. Maehler exhibited group photographs of members that were taken many years ago, presumably at Society meetings.

FEBRUARY 11, 1957

The 614th meeting convened at the Experiment Station, H.S.P.A., at 2:00 P.M. on Monday, February 11, 1957, with President Christenson in the chair.

Members present: Adachi, Awai, Beardsley, Bess, Bianchi, Bonnet, Boyle, Carter, Chilson, Chock, Chong, Christenson, Clagg, Einmo, Fullaway, Gressitt, Hardy, Isenberg, Ito, Joyce, Kajiwara, Keck, Look, Macdougall, Maeda, Maehler, Mitchell, Nakagawa, Nakata, Namba, Nishida, Ota, Pemberton, D. Rainwater, H. I. Rainwater, Rosa, Sakimura, Steiner, Tuthill, Warner, and Weber.

Visitors: Harry Hochman, James R. Holloway, James Y. Kim, Earle G. Linsley, Louis McGee, Elizabeth McMahan, and Thorndyke Roe, Jr.

Mr. Louis McGee and Miss Elizabeth McMahan were nominated for membership in the Society.

Mr. James Y. Kim was elected to membership in the Society.

The Secretary read a letter of thanks from the Zoological Society of London for our Society's customary annual contribution of fifty dollars, for 1956, to the Zoological Record Fund.

Dr. Carter presented an excellent Kodachrome-illustrated talk on his recent study of swollen shoot disease and insect pests of cacao in Ghana, Africa.

Notes and Exhibitions

Destruction of collections at the Hungarian National Museum: Drs. Gressitt and Hardy compared reports of damage at the Hungarian National Museum as a result of the recent uprisings in Hungary. The most recent and apparently most reliable information was received by Dr. Gressitt. He reported that word from Mrs. Szent-Ivany (via her husband in New Guinea) and from other sources indicated that the following groups were completely destroyed: Acarina, Orthoptera, neuropteroid insects, and Diptera other than acalyptrates. Several thousand Diptera types were destroyed, along with several large collections recently acquired: those of Pillich, Ruff, Sajo, and Thalhammer. The very important Horvath collection of Heteroptera was partly destroyed. Coleoptera and Lepidoptera were largely undamaged.

Miscellaneous notes and exhibits: Dr. Gressitt presented the following notes on entomologists and projects. Dr. K. Yasumatsu of Kyushu University, on his way back to Japan from a year's visit to the Mainland, was a visitor since the last meeting. Dr. J. Chester Bradley, Professor Emeritus of Cornell University, who is probably the most internationally honored American entomologist and President of the International Commission on Zoological Nomenclature, will be visiting Honolulu for a few weeks. He is scheduled to arrive on the 25th of this month and thus should be present at our next meeting. Dr. C. E. Mickel of the University of Minnesota is going to Korea for six months on an educational assistance program and will be in Honolulu from April 1st to 5th. Curtis W. Sabrosky of the U. S. Department of Agriculture (U. S. National Museum) will spend three months on Palau and Yap in connection with the Bishop Museum's Micronesia and zoogeography projects, on which the USDA, Navy, and Trust Territory are cooperating. Yoshio Oshiro of Honolulu is now working on Midway Island and will collect there for the Bishop Museum.

Dr. Gressitt also exhibited some Thailand insects, including rhinoceros beetles and *Scolia* species, and some new issues on Diptera in the Insects of Micronesia series, which included the Culicidae by Bohart, Bibionidae and Scatopsidae by Hardy, Asteiidae by Sabrosky, and Coelopidae by Hardy.

Mr. Clagg reported that Mr. George Hutton of the Bureau of Yards and Docks had examined the Navy's entomological work here. Mr. Hutton was in Honolulu from January 22nd to February 8th, when he continued on to Guam.

SPODOPTERA MAURITIA (Boisduval): Mr. Bianchi announced that on February 2nd he and Mr. Warner had been shown an infestation of the lawn armyworm in a yard at the Waialua House Lots, three or four miles from Lihue, Kauai. He was later informed that egg masses of this moth had been found by Dr. Pemberton during the same week at Kekaha, thirty miles west of Lihue. These findings verify an earlier, tentative, and unpublished report of the moth on Kauai by Mr. Au of the Territorial Board of Agriculture and Forestry.

DRYOTRIBODES LITTORALIS Zimmerman: Mr. Bianchi called attention to the description of this new curculionid from Hawaii (ENT. MO. MAG. 17(199): 276–278, 1956), remarking upon the unusual circumstance that the description is based upon specimens found in driftwood.

MARCH 11, 1957

The 615th meeting convened at the Experiment Station, H.S.P.A., at 2:00 P.M. on Monday, March 11, 1957, with President Christenson presiding.

Members present: Awai, Beardsley, Bess, Bianchi, Bonnet, Boyle, E. H. Bryan, Jr., Chock, Christenson, Clagg, Einmo, Fullaway, Gressitt, Hardy, Isenberg, Joyce, Kamasaki, Keck, Keiser, Kim, Look, Macdougall, Maeda, Mitchell, Nakata, Nishida, Ota, Pemberton, D. Rainwater, Steiner, Suehiro, Thistle, Tuthill, and Warner.

Visitors: Dr. and Mrs. J. Chester Bradley, L. R. Crockett, Louis E. McGee, and Elizabeth A. McMahan.

Mr. Louis E. McGee and Miss Elizabeth A. McMahan were elected to membership in the Society.

Dr. Pemperton spoke of the sudden and unexpected death on March 5th of Mr. Philip W. Weber, the Society's Editor. By vote of the membership the Secretary was instructed to send Mrs. Weber a letter of condolence and appreciation for services rendered the Society by her late husband. In accordance with Mrs. Weber's wishes, members were urged to contribute to the Hawaii Heart Fund instead of sending flowers.

Dr. J. Chester Bradley was introduced by Dr. Gressitt with a biographical sketch and delivered a most interesting talk entitled "Evolution of the Insect Orders."

NOTES AND EXHIBITIONS

CORYTHUCHA MORRILLI Osborn and Drake: Dr. Hardy reported a scarcity of this tingid bug on cocklebur in the Waianae section of Oahu, and Mr. Bianchi reported the same observation. It was first found in abundance on this plant in July 1953 ("PROCEEDINGS"[1] 15(2):282, 1954). The only

[1] Throughout this publication, "PROCEEDINGS" refers to the PROCEEDINGS OF THE HAWAIIAN ENTOMOLOGICAL SOCIETY.

explanation for the current low population of the bug appeared to be seasonal fluctuation.

EXPANSION OF ENTOMOLOGICAL FACILITIES AT BISHOP MUSEUM: On behalf of the Entomology Department of the Bishop Museum, Dr. Gressitt invited members and visitors of the Society to an open house, 3:00 to 5:00 P.M. on Thursday, April 4th, to celebrate the acquisition of an additional large room for use by the Entomology Department. Dr. C. E. Mickel, Chairman of the Department of Entomology, University of Minnesota, was to be a special guest and would speak about his department and of the work he would do in Korea. It was hoped that Curtis W. Sabrosky, on his way to Palau and Yap, would also be present. An exhibit of New Guinea insects would be shown and refreshments served.

PROPOSED CATALOGUE OF FAMILY NAMES: Dr. Gressitt spoke of a proposed catalogue of family names of insects to be prepared by the Entomological Society of America. This would not conflict with the rules or opinions of the International Commission on Zoological Nomenclature, he said. Dr. Bradley, himself President of the International Commission, ventured the opinion that the Commission would welcome any such stabilizing influence on family name usage as this list would likely prove to be.

APRIL 8, 1957

The 616th meeting convened at the Experiment Station, H.S.P.A., at 2:00 P.M. on Monday, April 8, 1957, with President Christenson presiding.

Members present: Adachi, Balock, Beardsley, Bess, Boyle, Carter, Chock, Christenson, Clagg, Einmo, Fullaway, Gressitt, Haramoto, Hardy, Joyce, Kajiwara, Kamasaki, Keck, Look, Maehler, McGee, Nakata, Nishida, Pemberton, D. Rainwater, Sakimura, Steiner, Suehiro, and Tuthill.

Visitor: Curtis W. Sabrosky.

Dr. Gressitt introduced Curtis W. Sabrosky of the U. S. Department of Agriculture. Mr. Sabrosky presented an interesting discussion of (1) the relationship between the U. S. National Museum and U. S. Department of Agriculture taxonomists who do their work at the Museum, (2) the field of interest of each taxonomist, and (3) his own current studies on the dipterous genus *Protocalliphora*. Mr. Sabrosky stated that Dr. Adam G. Böving had died of a heart attack about a month previously, and Miss Ina L. Hawes of cancer within the week.

NOTES AND EXHIBITIONS

DERMACENTOR ALBIPICTUS (Packard): Dr. Joyce reported that a large number of specimens of the winter tick were taken from a horse in upper

Manoa Valley, Oahu, early in January 1957. Many adults and nymphs were found on the horse, which had been imported from Montana about the middle of December 1956. Steps were immediately taken to destroy the infestation and prevent the establishment of the tick in Hawaii. The horse was treated with a lindane dip, and the corral and surrounding area were also treated in an effort to kill any adults that might have dropped off the host. Having a more northerly range, the winter tick would perhaps be poorly adapted to the Hawaiian climate. Had the horse been imported during the summer, however, the tick might well have been *D. andersoni* Stiles, the vector of Rocky Mountain spotted fever.

Dr. Joyce noted that this occurrence points up the ever-present possibility of the establishment of such dangerous species in Hawaii, and he then presented a summary of the winter tick's life cycle and taxonomic characters. Dr. Hardy was led to question the adequacy of current inspection procedures on incoming livestock in the light of this event. Dr. Pemberton suggested that this could constitute an argument against establishing the axis deer on other of the Hawaiian Islands than Molokai, as some wish.

PHYTOBIA (AMAUROMYZA) MACULOSA (Malloch): Dr. Hardy exhibited specimens and stated that he had found this agromyzid fly mining the leaves of burdock, *Arctium lappa* L., and sweet potato, *Ipomoea batatas* (L.), on the University Farm and that Mr. Beardsley had reared it from *Gnaphalium* sp. in March 1957. This fly evidently attacks a wide range of Compositae and other plants and may prove of considerable economic importance. It was first reported in Hawaii by Dr. Hardy at the July 9, 1956, meeting ("PROCEEDINGS" 16(2):188, 1957).

INSECTS ON ALFALFA, *Medicago sativa* L.: Dr. Hardy reported the following insects attacking alfalfa in poor condition at Poamoho, Oahu, in March 1957: *Pseudococcus brevipes* (Cockerell) on roots, and *Hemiberlesia rapax* (Comstock) and *Vanduzea segmentata* (Fowler) above ground, the latter in large numbers. These pests, however, did not appear to be wholly responsible for the bad condition of the alfalfa. Apparently they have not previously been recorded on this host in Hawaii.

ORTHOTYLUS IOLANI Kirkaldy: Mr. Beardsley exhibited specimens of this mirid bug that were collected on the foliage of wiliwili trees, *Erythrina sandwicensis* Degener, on the Waialua side of Mt. Kaala, Oahu, at about 500 to 1500 feet elevation on March 24, 1957. All the wiliwili seen in the area were heavily infested with these bugs, and damage to foliage was evident in the form of minute chlorotic spots at the sites of individual feeding punctures.

UNIDENTIFIED CARABIDAE: Specimens of two species of unidentified ground beetles, apparently previously unrecorded immigrants, were shown by Mr. Beardsley. One minute species had been taken only in H.S.P.A. light traps located in Ewa and Waipio, Oahu. The second and larger species had also

been taken in the Ewa light trap, and additional specimens were collected at Hilo and Naalehu, Hawaii, by students in the beginning entomology course at the University of Hawaii.

APION ANTIQUUM Gyllenhal AND DUNG BEETLES: Mr. Chock exhibited specimens of several beneficial beetles recently released by the Board of Agriculture and Forestry for biological control of plant and insect pests. The weevil, *A. antiquum*, was released to control *Emex spinosa* Campd. and *E. australis* Steinh. and showed considerable promise. The several species of scarabaeid dung beetles were sent from Southern Rhodesia by Mr. Krauss and were liberated very recently on Hawaii for control of the horn fly, *Siphona irritans* (L.), by disposing of cattle manure.

ORCHIDOPHILUS ATERRIMUS (Waterhouse): Dr. Carter noted that this weevil pest of orchids was apparently becoming more abundant and was beginning to occur on *Cattleya* flowers—a new phenomenon—and commonly on other orchid flowers.

OPIUS FORMOSANUS Fullaway IN COSTA RICA: President Christenson reported that this braconid parasite had been recently recovered from an *Anastrepha* species and *Ceratitis capitata* (Wiedemann), the Mediterranean fruit fly, in Costa Rica. This was the first recovery of any parasite shipped to that area from Hawaii, but it was not yet definite whether the parasite was permanently established there.

ERADICATION OF MEDITERRANEAN FRUIT FLY IN FLORIDA: Mr. Steiner stated that the area still under treatment in Florida for eradication of *Ceratitis capitata* (Wiedemann) had been reduced to 13,000 acres. Only 24 flies were taken in the 50,000 traps in use in February, and 13 flies in March. Another 10,000 traps were to be put in use right away. A new synthetic lure, perhaps even better than *Angelica*-seed oil, had been developed and was to be employed immediately.

ENTOMOLOGICAL PROJECTS AT B. P. BISHOP MUSEUM: Dr. Gressitt presented the following information:

"The project 'Zoogeography of Pacific Insects' has been enlarged with the addition of another technician and a half-time field-worker. Wm. W. Brandt has been employed jointly by Bishop Museum and the Administration of the Territory of Papua and New Guinea (in cooperation with the Commonwealth Scientific and Industrial Research Organization). He started last October, working first on Normanby I., then on Woodlark I., and proceeds next to the Owen Stanley Mts. The Lepidoptera will go to Canberra; other insects to Bishop Museum, with duplicates to Port Moresby.

"Field work was done in 1956 by E. J. Ford, Jr. and myself in NE. Australia, E. New Guinea, New Britain, New Ireland, Bougainville and Guadalcanal. In 1957 (late July to late December) I shall go to New Hebrides, E. Solomons, N. New Guinea, N. Borneo and Thailand. With the cooperation

of the USDA and the Office of Naval Research, we are sending C. W. Sabrosky to Palau, Yap and Guam from April through June. We hope to send D. E. Hardy to New Guinea this year. E. G. Munroe and Geo. Holland are being sent to New Guinea for field work this year by the Canada Dept. of Agriculture, in cooperation with this project.

"It is hoped to commence publishing on New Guinea area insects within two years. Sixteen issues of INSECTS OF MICRONESIA have appeared; two more are nearly off the press; and others in press. The facilities of the Entomology Dept., Bishop Museum have been further augmented by additional floor space and new cases."

MAY 13, 1957

The 617th meeting convened at the Experiment Station, H.S.P.A., at 2:00 P.M. on Monday, May 13, 1957, with President-elect Tuthill in the chair.

Members present: Balock, Beardsley, Bess, Bonnet, Boyle, Carter, Chilson, Fullaway, Gressitt, Haramoto, Hardy, Isenberg, Joyce, Kajiwara, Kamasaki, Kim, Look, Macdougall, McGee, Nakata, Nishida, Pemberton, Sakimura, Steiner, Suehiro, Tuthill, and Warner.

Visitor: James F. Cooper.

Mr. Steiner introduced Mr. James F. Cooper, who spoke briefly of his work at the U. S. Department of Agriculture's fruit fly laboratory in Mexico City.

Dr. Bess delivered a Kodachrome-illustrated talk entitled "Entomological Work in Canada."

NOTES AND EXHIBITIONS

Mr. Beardsley exhibited specimens and presented notes on the following three species:

PHANEROPTERA FURCIFERA Stål (see photograph): A male specimen of this tettigoniid grasshopper was taken in an H.S.P.A. light trap at Waipio, Oahu, on April 15, 1957. Subsequently, two additional specimens, a second adult male and a female nymph, were collected by sweeping *Desmanthus* and *Leucena glauca* (L.) Benth. in the vicinity of the trap. This species appears to be a recently established immigrant. Material was identified by Dr. Ashley B. Gurney of the U. S. Department of Agriculture, who stated that he had specimens on hand from Guam and Luzon. Dr. Gurney noted that this is apparently the same species that Swezey called *brevis* in his 1946 report on Guam Orthoptera and called attention to a new revision of *Phaneroptera* by Dr. David R. Ragge of the British Museum (PROC. ZOOL. SOC. LONDON 127(2):205–283, 1956).

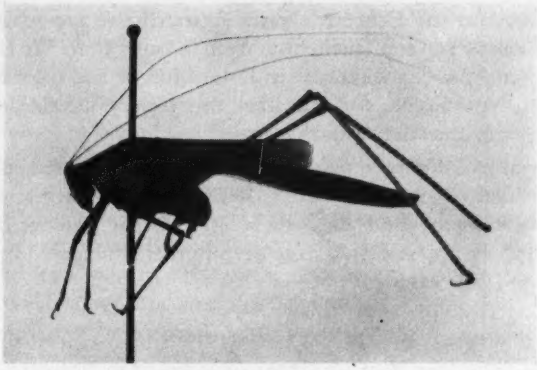


FIG. 1. *Phaneroptera furcifera* Stål, male (approximate length to tip of hind wings, 30 mm.)

METIOCHE VITTATICOLLIS (Stål): Mr. Beardsley collected this small cricket at Kawela, Molokai, on December 12, 1956—a new island record. It was previously recorded from Oahu, Niihau, Maui, and Hawaii and probably occurs on all the Islands.

ACRAPEX, undescribed species: Four specimens of this phalaenid moth, probably an immigrant species, were taken by Mr. Beardsley in a light trap operated by him at his home in Aina Haina, Oahu, during December 1956 and March 1957. A pair was sent to Mr. D. F. Fletcher at the British Museum, who writes that they apparently belong to an undescribed form. This species is larger than *A. examinis* (Meyrick), the only closely related species known in the Islands, and has markedly different male antennae. The larvae of this new form will probably be found boring in grasses.

TERMITE FUMIGATION: Dr. Bess exhibited a wooden-block type of container being used in fumigation tests against the dry-wood termite, *Cryptotermes brevis* (Walker). Termites are confined in a smaller wood-and-glass cage, which is then sealed within the larger block by a glass plate with paraffin around the edges. The blocks were designed to obtain a measure of the relative effectiveness, in terms of penetrating power, of methyl bromide and "Vikane" (sulfuryl fluoride—a product of Dow Chemical Company) in tent fumigation of buildings.

XYLOTRECHUS sp. on Midway Island: Dr. Gressitt reported that Yoshio Oshiro had been sending insects from Midway, which included a number of new records. One specimen taken from imported lumber was a North American cerambycid beetle of the genus *Xylotrechus*, a borer of hardwood.

TRAPPING OF AIRBORNE INSECTS: Dr. Gressitt stated that experiments had been initiated at the Bishop Museum to test trapping of airborne insects. The main objective was to develop techniques for collecting such insects over the ocean from ships or planes and on atolls or other small

islands to study natural dispersal. Various adhesives had been used on screen in rotating metal cylinders facing the wind and on paper attached to horizontal boards. Certain banding materials received from the California Spray-Chemical Company proved to be far superior to "Tree Tanglefoot" and held up the longest through bad weather. Regardless of the adhesive used, however, it was found difficult to get good specimens because of the necessity of removing them from the adhesive and the need for using non-aqueous solvents in the process. In experiments conducted so far, atop the Bishop Museum, some of the insects taken appeared to be native species blown off the Koolau Mountains. To date, the following numbers of various groups had been taken: 2 spiders, 11 Psocoptera, 16 Isoptera, 7 Homoptera, 8 Heteroptera, 59 Lepidoptera, 14 Coleoptera, 89 Diptera, and 69 Hymenoptera. At least 41 families and a larger number of species were represented. Microlepidoptera and Nematocera were most numerous.

Dr. Gressitt also announced that Mrs. Philip W. Weber had donated her late husband's insect collection to the Bishop Museum.

REARING OF PSEUDOCOCCUS BREVIPES (Cockerell): Dr. Carter reported that his experimental work with the pineapple mealybug had been facilitated by a simple rearing technique discovered by an assistant, Mrs. Tatsuko Kurata. This mealybug gets very large on sisal leaves, *Agave sisalana* (Engelm.) Perrine, and when leaves are cut and placed on the ground beneath the plant, great numbers of gravid females can be harvested from the leaves periodically.

RADFORDIA ENSIFERA (Poppe): Dr. Joyce stated that he had collected this myobiid mite from a rat on April 12, 1957. This is a new mite record for the Territory.

BLABERUS sp. from ship: Dr. Joyce exhibited a large roach, thought to be a species of *Blaberus*, that was taken on an old ship in Honolulu Harbor on its way to Japan for dismantlement. Species of this genus, which includes the largest of the roaches, are common in Central America and Mexico.

JUNE 10, 1957

The 618th meeting convened at the Experiment Station, H.S.P.A., at 2:00 P.M. on Monday, June 10, 1957, with President Christenson presiding.

Members present: Adachi, Balock, Beardsley, Bess, Bianchi, Bonnet, Boyle, Chilson, Chong, Christenson, Einmo, Ford, Gressitt, Joyce, Kamasaki, Keck, Look, Maeda, McGee, Nakata, Ota, Pemberton, D. Rainwater, Rosa, Steiner, Suehiro, and Tuthill.

Visitors: Dr. Arthur K. Burditt, Jr., Francisco A. Estrada, and James R. Holloway.

Dr. Arthur K. Burditt, Jr., and Mr. James R. Holloway were nominated for membership in the Society.

Mr. Bianchi delivered an interesting talk on "Sugarcane Insects," which stimulated a considerable amount of lively discussion.

Notes and Exhibitions

Eradication of Mediterranean fruit fly in Florida: President Christenson reported that Mr. Steiner had been granted the U. S. Department of Agriculture's AWARD FOR SUPERIOR SERVICE. The citation reads, "for invaluable service to the cooperative Mediterranean fruit fly eradication campaign in Florida, made possible by far-sighted planning, organization, coordination, and execution of chemical control research on this destructive insect."

Mr. Steiner exhibited a map showing areas of current and past infestations of the Medfly in Florida. About 30,000 acres in four counties were still being sprayed, as compared with a past maximal infestation of approximately 795,000 acres in 28 counties. A slight increase in the size of the infested area had occurred during May because of infestations that had survived the winter without detection.

Insects of Hawaii series: Dr. Tuthill announced that the University of Hawaii Press had been granted $20,000 by the National Science Foundation for the continued publication of this series. Volume six on the Neuroptera, by Zimmerman, was expected to be off the press shortly.

Oxyethira maya Denning: Miss Adachi reported for Dr. Hardy that this caddisfly was taken in a light trap at Hilo, Hawaii, by Susumu Nakagawa in April 1957. It had previously been recorded only from Oahu.

Pseudococcus maritimus (Erhorn): Miss Adachi also reported for Dr. Hardy that the grape mealybug had been found severely damaging white clover on the University of Hawaii's experimental farm at Waimanalo. Material was held, but no parasites or predators were recovered.

Heliothis virescens (Fabricius): Mr. Beardsley exhibited hibiscus flowers that were partly eaten by the tobacco budworm—a new food record for this phalaenid.

Calendra cariosa (Olivier): Mr. Ford announced that he had collected this billbug in his back yard at Wahiawa, Oahu. This curculionid was first recorded in the Territory from a single Oahu specimen by Mr. Beardsley in 1956 ("Proceedings" 16(2): 190, 1957).

Termite fumigation: Dr. Bess reported that experiments completed to date indicated that Dow Chemical Company's "Vikane" was a better penetrant than methyl bromide and had the added advantage of not damaging rubber and certain other materials as did the latter gas. However, this new fumigant was not yet available on the market.

TRAPPING OF AIRBORNE INSECTS: Dr. Gressitt announced that experiments in trapping airborne insects were continuing and that plans were being made to do trapping on Eniwetok, Jarvis, Wake, and other isolated small islands or atolls in the Pacific, as well as on ships. Further trapping on the roof of the Bishop Museum had produced large numbers of specimens, which were to be detailed later. Termites were frequently trapped on the back (leeward) side of rotary traps facing the wind, which indicated that they were flying against the wind, above the building. California Spray-Chemical Company's experimental "Deadline" had proved to be the most effective trapping agent, but it was found difficult to remove specimens from it without damaging them. Resin-castor oil was found better from that standpoint, but it required re-application much more often and did not catch so many insects.

HOW MOSQUITOES REACHED HAWAII: Dr. Bonnet called attention to an article by William T. Brigham entitled "Ka Hana Kapa—*The Making of Bark Cloth in Hawaii*" (MEM. B. P. BISHOP MUS. 3:197, 1911), in which the author gives a presumably authentic account of the introduction of mosquitoes into Hawaii.

Brigham states: "Kapa (bark cloth) was used at times for screens and partitions in houses and on the southern islands for mosquito nets, like the *Tinamu* of the Samoans. The Hawaiians had none of these very troublesome insects before 1827 when they were maliciously introduced by a wicked white man.[86] If a white man brought the pest, other white men brought mosquito netting far superior to any made of Kapa and so no Hawaiian *Tinamu* was invented."

Footnote 86 indicated in the paragraph above is as follows: "Objection having been made to the use of the words *maliciously* and *wicked* by a member of the Publication Committee, I add the following account of the introduction of this pest, which all people are desirous of banishing, and many governments are trying at considerable expense to exterminate with more or less success. In 1864, while the guest of Rev. Dr. D. Baldwin of the American Mission at Lahaina, Maui, I was told by my host that in 1827 the master of a trading vessel then lying off the port of Lahaina was refused an unlimited supply of women on his vessel, also found difficulty in getting all the intoxicants he desired. This was the order of the native chiefs, but, as usual in those times, it was imputed to the missionary company, and the disappointed mariner vowed vengeance on the supposed disturbers of his revels. On his next voyage he brought a tub of stagnant water with a supply of the enemy and landed it at Lahaina. Not long after a native came to Dr. Baldwin with a mosquito, which he called 'a fly which bites,' and the doctor recognized the insect which he had never seen on the Hawaiian Islands before. I leave to my readers whether such an act was malicious, and whether the fellow who did it was wicked. I may add that he openly boasted of his deed."

CACTOBLASTIS CACTORUM (Berg): Dr. Bonnet reported that larvae of this phycitid moth were destroying *Opuntia* cactus on the island of Niihau. Ranchers there consider this undesirable because the cactus is useful as cattle forage during droughts. Mr. Bianchi noted that he had recently searched for *Cactoblastis* on Kauai without finding it.

ANTHRAX DISTIGMA Wiedeman: Mr. Bianchi stated that this bombyliid was becoming more common on Oahu. The fly is gentle and sometimes hovers near a person's face to explore the nasal and other openings. This habit suggests that it may parasitize something besides mud dauber and potter wasps.

CHLORION (ISODONTIA) HARRISI Fernald; CHLORION THOMAE (Fabricius): Miss Suehiro reported that these two immigrant cricket wasps were collected on Kauai in 1956 by Mr. Isenberg, the first Hawaiian record for these species outside of Oahu. *Chlorion harrisi*, first collected in 1930 at Waianae, Oahu, by Drs. Swezey and Williams and collected occasionally on Oahu since, was taken at Lihue, Kauai; and *C. thomae*, first captured by Mr. Bianchi at Kaelepulu Pond in Kailua, Oahu, in 1953, was taken at Anahola, Kauai.

JULY 15, 1957

The 619th meeting convened at the Experiment Station, H.S.P.A., at 2:00 P.M. on Monday, July 15, 1957, with President Christenson in the chair.

Members present: Adachi, Balock, Beardsley, Bess, Bonnet, Boyle, Carter, Chong, Christenson, Gressitt, Holway, Isenberg, Joyce, Kajiwara, Kamasaki, Kim, Look, Macdougall, Maeda, McGee, Nakata, Namba, Nishida, Ota, Pemberton, D. Rainwater, Suehiro, and Woolford.

Visitors: Dr. Arthur K. Burditt, Jr., Francisco A. Estrada, James R. Holloway, Alan J. Kohn, Dr. Albert R. Mead, and Harold Toba.

Dr. Arthur K. Burditt, Jr., and Mr. James R. Holloway were elected to membership in the Society.

Dr. Carter gave a brief report on the Forty-first Annual Meeting of the Pacific Branch of the Entomological Society of America at Portland, Oregon, June 26 to 28, 1957.

Dr. Pemberton showed a 15-minute color motion picture on the biological and cultural control of the coconut rhinoceros beetle, *Oryctes rhinoceros* (L.), in the Palau Islands.

Dr. Bonnet delivered an interesting account, illustrated by Kodachrome slides, of his work on filariasis in the South Pacific.

NOTES AND EXHIBITIONS

GEOCOCCUS RADICUM Green: Dr. Namba reported that he had recently received specimens of this mealybug collected on the roots of coffee seed-

lings on the island of Hawaii. This is a new host record and a new island record for the species, which was originally described from the roots of grass in Ceylon. Its other hosts in Hawaii include *Acacia koa* Gray, *Caladium*, croton, *Cyperus rotundus* L., ferns, *Gerbera*, mango, palms, pineapple, and *Indigophora*.

HYPURUS BERTRANDI (Perris): Dr. Gressitt called attention to a paper by Dr. E. C. Zimmerman on this species: "The Portulaca Leafmining Weevil, *Hypurus bertrandi*, in Hawaii (Coleoptera: Curculionidae: Ceutorhynchinae)" (ANN. ENT. SOC. AMERICA 50(3):221–222, 1957).

DACUS UMBROSUS Fabricius and D. FRAUENFELDI Schiner: Dr. Gressitt announced that since the last meeting Curtis W. Sabrosky had returned from a very successful collecting trip to the Palau and Yap Islands. In Palau he collected a fruit fly new to Micronesia, *D. umbrosus*, which was taken in large numbers, all males, in traps baited with methyl eugenol. As it was taken throughout the Palaus, it may have been there for some time. It is recorded from breadfruit in Indonesia and the Philippines. *Dacus frauenfeldi* was taken in numbers in traps baited with anisyl acetone.

NEW INSECTS AND MITES ON GUAM AND BONIN ISLANDS: Dr. Gressitt stated that both Dr. W. W. Cantelo and Dr. A. A. LaPlante had sent specimens to the Bishop Museum of a fruit fly intercepted at Guam in tomatoes from the Bonin Islands. The species is *Dacus dorsalis* Hendel rather than *D. boninensis* described by Hardy (INSECTS OF MICRONESIA 14(1):12–14, 1956). Dr. Cantelo also sent lists of partially identified species representing several new records for Guam. These included *Erionota thrax* (L.), a hesperiid butterfly whose larvae attack banana, and some mites, leafhoppers, scales, aleyrodids, and others, from several agricultural crops. Also submitted were the larvae of a crane fly that were found in the growing point of banana on Agrihan Island.

The following three notes were also presented by Dr. Gressitt:

INSECTS OF MICRONESIA series: A new issue of this series is off the press: "Coleoptera: Elateridae" by R. H. Van Zwaluwenburg (Vol. 16, No. 1). The Bishop Museum has engaged Mrs. D. Blumenstock as a half-time entomological editor, and Mr. Carl Isenberg has also been employed in the Entomology Department.

ENTOMOLOGISTS VISITING HAWAII: Among recent visitors to Hawaii were Drs. George Holland and E. G. Munroe of the Division of Systematic Entomology and Biological Control at Ottawa, Canada, who were on their way to New Guinea, and Dr. Bernard V. Travis of Cornell University en route to Los Baños, the Philippines.

TRAPPING OF AIRBORNE INSECTS: As a part of the Bishop Museum's program for trapping airborne insects, traps have been constructed of frames

holding aluminum screening. These will probably be installed on military transports crossing the Pacific.

EUSPHYRUS RECTUS Schaeffer: Mr. Beardsley reported that the small anthribid beetle first recorded by him in May 1956 from light-trap material ("PROCEEDINGS" 16(2):186, 1957) had recently been identified by Dr. E. C. Zimmerman as this species. This beetle was described from Texas (TRANS. AMERICAN ENT. SOC. 32:271–272, 1906).

PISON INSULARE Smith: Mr. Isenberg stated that he had collected one specimen of this sphecid wasp at Lihue, Kauai, in August 1956—a new island record. It was first collected in the Territory on the Kawaiiki Trail in the Koolau Mountains, Oahu, by P. W. Weber ("PROCEEDINGS" 13(2):222, 1948; 13(3):332, 1949). This species is readily distinguished from other Hawaiian species of *Pison* (except *hospes*) by its large size, 9.5 to 11 mm.

AUGUST 12, 1957

The 620th meeting convened at the Experiment Station, H.S.P.A., at 2:00 P.M. on Monday, August 12, 1957, with President Christenson presiding.

Members present: Adachi, Balock, Beardsley, Bess, Biachi, Bonnet, Boyle, Burditt, Carter, Chilson, Christenson, Ford, Haramoto, Holloway, Isenberg, Joyce, Kamasaki, Keck, Keiser, Look, Maeda, Maehler, McGee, Mitchell, Nakata, Namba, Nishida, Ota, Pemberton, D. Rainwater, Suehiro, Tuthill, and Warner.

Visitors: Francisco A. Estrada, Dr. Blair McGugan, Dr. Albert R. Mead, and Edward L. Mockford.

Mr. Francisco A. Estrada was nominated for membership in the Society.

By vote of the membership, the Secretary was instructed to send a draft in the amount of fifty dollars to the Zoological Society of London as our Society's customary annual contribution toward the publication of the ZOOLOGICAL RECORD.

Dr. Albert R. Mead, Chairman of the Department of Zoology, University of Arizona, spoke of his current research on a disease of the giant African snail, which he is studying here. He exhibited a large specimen showing the syndrome associated with the disease.

Mr. Francisco A. Estrada presented a Kodachrome-illustrated account of entomological research in Nicaragua.

NOTES AND EXHIBITIONS

CONOTELUS MEXICANUS Murray: Mr. Ford exhibited larvae and pupae of this immigrant nitidulid beetle, which he found breeding in decaying flowers of double pink hibiscus. He stated that the eggs of this beetle are deposited in various flowers soon after they open and that they hatch after

the flowers fall to the ground. The larvae feed upon the decaying flowers, and completion of the life cycle is dependent upon the length of time during which the flowers retain sufficient moisture.

NEW RECORDS OF SCOLYTID BEETLES: Mr. Ford presented notes on the following species of bark beetles that he had collected and which were determined by Dr. S. L. Wood: (1) *Ericryphalus henshawi* Hopkins was bred from *Ilex anomala* f. *sandwicensis* (Endl.) Loes. and *Acacia koa* Gray from various localities on Oahu during 1951 to 1954. This is a new record for the Territory. (2) *Hypothenemus mauiensis* Schedl has been known heretofore only from Maui. Three specimens were bred from *Citrus sinensis* (L.) Osbeck collected at Moanalua Gardens, Oahu, in March 1953—a new island record. (3) *Stephanoderes hivaoea* Beeson has not been recorded previously from the Territory. Specimens were collected at Waianae, Oahu, in August 1949. This name may possibly be a synonym of *S. hawaiiensis* Schedl.

ICERYA PURCHASI Maskell: Dr. Tuthill reported that on July 6, 1957, he collected specimens of the cottony cushion scale on a *Casuarina* tree on Eniwetok Atoll in the Marshall Islands. It appeared that the scales had been imported with the tree, which was heavily infested; and scales were beginning to spread to adjacent vegetation. *Icerya purchasi* has not been reported previously from the Marshall Islands, although a related species, *I. aegyptiaca* (Douglas), is known from several of the Marshall atolls and is sometimes a serious pest of breadfruit and citrus. The scales were identified by Mr. Beardsley.

NEOPTINUS, undescribed species: Mrs. Rainwater stated that the ptinid beetle that she had previously reported from Kauai ("PROCEEDINGS" 16(2): 195, 1957) was determined by Dr. R. D. Pope of the British Museum as an undescribed species of *Neoptinus*.

PYEMOTID MITE ATTACKING MAN: Dr. Boyle reported that on July 16 he accompanied Mr. William Komoda of Vet's Termite Control to the Honolulu Myohoji Mission at 2003 Nuuanu Avenue, to investigate complaints apparently involving a biting arthropod. The building had been fumigated for dry-wood termites in April, and was found to be infested on the inside with a mite similar to *Pyemotes ventricosus* (Newport), the straw itch mite. The mite was issuing from termite burrows in large numbers and had presumably bred up to a large population on dead termites. Many specimens were taken, including gravid females. Local pest control operators state that this type of infestation occasionally occurs after a building is fumigated for termite control. Dr. Boyle stated that he suffered at least 50 mite bites, the symptoms of which were very like those described on pages 166 and 167 of Baker and Wharton's AN INTRODUCTION TO ACAROLOGY (Macmillan, 1952).

VANDUZEA SEGMENTATA (Fowler): Dr. Pemberton reported that Mr. Davis had recently found this membracid attacking the blossoms of ohia lehua, *Metrosideros collina polymorpha* (Gaud.) Rock, on the island of Hawaii.

Nymphs were found in great abundance in infested blossoms. This is a new host record for the insect.

TENEBRIO MOLITOR L.: Miss Suehiro exhibited an adult specimen of the yellow mealworm that was collected in Honolulu by Dr. R. C. L. Perkins during the 1890's. This cosmopolitan pest of stored products has never been recorded in our literature and no other Hawaiian specimens are known, although the closely related dark mealworm, *T. obscurus* Fabricius, was once collected in the Bishop Museum building.

COCCINELLA CALIFORNICA Mannerheim: An adult specimen of this ladybird beetle was exhibited by Miss Suehiro. It is a California species that is occasionally taken in Hawaii on fruits and vegetables from the West Coast, but it is not known to be established here. The specimen exhibited was collected at Koloa, Kauai, on August 8, 1956. This is the first record of the beetle having been collected on an island other than Oahu.

ADORETUS SINICUS Burmeister: Dr. Carter reported that adult Chinese rose beetles had attacked intermediate pineapple plants in a number of spots over an area of about 1800 acres in the Poamoho region of Oahu. This damage involved an unusually large area and indicates that a very large population of beetles must have built up in areas adjacent to pineapple fields.

DEROCERAS LAEVE (Müller): Dr. Albert R. Mead exhibited a specimen of this slug, which he had found widely distributed on Oahu. The species has not been previously reported from the Territory. The name *Agriolimax gracilis* Rafinesque is a synonym.

SEPTEMBER 9, 1957

The 621st meeting convened at the Experiment Station, H.S.P.A., at 2:00 P.M. on Monday, September 9, 1957, with President Christenson in the chair.

Members present: Adachi, Balock, Bess, Bianchi, Bonnet, Boyle, Burditt, Carter, Christenson, Clagg, Davis, Haramoto, Hardy, Holway, Kajiwara, Kim, Maehler, Macdougall, Maeda, Mitchell, Namba, Nishida, Pemberton, Rosa, Sherman, and Steiner.

Visitors: Francisco A. Estrada, Dr. John M. Hirst, M. E. Jefferson, and Norimitsu Tanaka.

Dr. John M. Hirst and Mr. Norimitsu Tanaka were nominated for membership in the Society.

Mr. Francisco A. Estrada was elected to membership in the Society.

Mr. M. E. Jefferson spoke briefly on recent advances in the use of radiation in entomology and exhibited photographs of the new cobalt-60 radiation unit he had just helped install at the U. S. Department of Agriculture's fruit fly laboratory in Honolulu.

Mr. Davis presented an interesting Kodachrome-illustrated account of his recent explorations for insect enemies of *Halogeton* species in southern Europe and the Near East.

Notes and Exhibitions

Rodolia cardinalis (Mulsant) to Eniwetok: Dr. Pemberton stated that Dr. Tuthill had left recently for the island of Eniwetok, where he was to liberate a shipment of the vedalia ladybird beetle prepared for him by Mr. Beardsley.

October 14, 1957

The 622nd meeting convened at the Experiment Station, H.S.P.A., at 2:00 P.M. on Monday, October 14, 1957, with President-elect Tuthill presiding.

Members present: Adachi, Awai, Balock, Bess, Bianchi, Boyle, Burditt, Chilson, Chock, Chong, Clagg, Estrada, Ford, Fullaway, Haramoto, Hardy, Hinckley, Holloway, Kajiwara, Kamasaki, Look, Macdougall, Maeda, McGee, Nishida, Ota, Pemberton, Rosa, Sherman, Steiner, Tuthill, and Woolford.

Visitors: Dr. John M. Hirst and Norimitsu Tanaka.

Dr. John M. Hirst and Mr. Norimitsu Tanaka were elected to membership in the Society.

President-elect Tuthill read a cablegram from Mr. Christenson, recently transferred to Washington, in which Mr. Christenson formally resigned the Presidency of the Society and conveyed his best wishes for a successful future.

Dr. Sherman presented an excellent Kodachrome-illustrated discussion of entomological research in Japan, where he had recently spent a sabbatical leave on research supported by a Fullbright grant.

Notes and Exhibitions

Corythucha morrilli Osborn and Drake: Dr. Sherman stated that on September 17 numerous adults and nymphs of this tingid bug had been found attacking false ragweed, *Franseria strigulosa* Rydb., on the Nakama farm at Kamooloa, Waialua, Oahu.

Coccotrypes carpophagus (Hornung): Mr. Chilson reported rearing large numbers of this scolytid beetle from seeds of the golden-fruited palm, *Chrysalidocarpus lutescens* (Bory) Wendl., collected during May 1957 in Honolulu. Adults were determined by Dr. W. H. Anderson of the U. S. Department of Agriculture. The species was first reported as new to the Territory by Mr. Van Zwaluwenburg in July 1955 ("Proceedings" 16(1):9, 1956).

Tricentrus albomaculatus Distant: Mr. Chilson announced that this membracid had been intercepted three times over the past few years on

Acalypha wilkesiana Muell.-Arg., in the course of pre-departure inspection of baggage going to the Mainland. This appears to be a new host record for the Territory.

CACTOBLASTIS CACTORUM (Berg): Mr. Fullaway reported that Mr. Stephen Au had found this phycitid moth established on Kauai early in September. Mr. Bianchi stated that he had found the species on nearly every cactus plant examined by him in the Koloa-Makahuena Point area of Kauai during the week of October 7 to 12, and that judging from the amount of feeding the moth had probably been on the island for several months.

NOVEMBER 18, 1957

The 623rd meeting convened at the Experiment Station, H.S.P.A., at 2:00 P.M. on Monday, November 18, 1957, with President Tuthill in the chair.

Members present: Adachi, Awai, Balock, Bess, Bianchi, Boyle, Burditt, Chong, Clagg, Davis, Fullaway, Haramoto, Hardy, Hirst, Holloway, Kajiwara, Keiser, Kim, Macdougall, Maeda, Maehler, Mitchell, Nakata, Nishida, Ota, D. Rainwater, Rosa, Sherman, Suehiro, Thistle, and Tuthill.

Visitor: Miss Shiu-Chen Chiu.

Dr. Hardy presented a most interesting Kodachrome-illustrated discussion of his recent trip of entomological exploration in New Guinea.

NOTES AND EXHIBITIONS

THERAPHOSID SPIDER: Dr. Hardy exhibited a large bird spider of the family Theraphosidae (popularly called "tarantulas" in the southwestern United States) that had been intercepted by a Territorial quarantine officer in an automobile shipped from the Mainland. There followed some discussion of this interception and quarantines in general.

DECEMBER 9, 1957

The 624th meeting convened at the Experiment Station, H.S.P.A., at 2:00 P.M. on Monday, December 9, 1957, with President Tuthill presiding.

Members present: Adachi, Awai, Balock, Bess, Bianchi, Boyle, Burditt, Carter, Chong, Clagg, Davis, Fullaway, Haramoto, Hardy, Holloway, Isenberg, Joyce, Kajiwara, Kamaski, Keiser, Kim, Look, Maeda, Maehler, McGee, Mitchell, Nakata, Namba, Nishida, Ota, D. Rainwater, Rosa, Sakimura, Sherman, Suehiro, Tamashiro, Tuthill, and Woolford.

Visitors: Naoki Hatai and Torao Kobayashi.

The death on November 28 of "Prof. Harry" Smith, Emeritus Professor of Entomology, University of California, and Honorary Member of our Society,

was announced. By vote of the membership, the Acting Secretary was directed to write a letter of condolence to Prof. Harry's family. (See obituary elsewhere in this issue.)

The following officers were elected for 1958:

President.....L. D. Tuthill
President-elect.....Toshiyuki Nishida
Secretary.....J. W. Beardsley
Treasurer.....W. C. Mitchell
Advisor.....C. E. Pemberton

Mr. Naoki Hatai, an entomologist with the National Institute of Agricultural Sciences in Tokyo, Japan, and Mr. Torao Kobayashi, President of the Kyoritu Noki Company in Tokyo, were introduced by Dr. Bess. Mr. Hatai presented a brief account of his current tour of the mainland United States and Hawaii.

Mr. Tamashiro, recently returned from two years of graduate work at the University of California, Berkeley, discussed some of the entomological projects currently in progress at that institution.

Notes and Exhibitions

Mr. Bianchi presented the following notes for Mr. Beardsley, currently on study leave in Washington, D. C.

Halictus (Chloralictus) sp.: Two specimens of this little halictid bee were collected in the Makiki section of Honolulu during 1957. The first was taken by Mr. R. Yee, a University of Hawaii entomology student, during April; and the second was taken by Mr. Beardsley on the grounds of the H.S.P.A. Experiment Station during September. The specimens were identified by Dr. Karl V. Krombein of the U. S. Department of Agriculture, who noted that the bee is probably a species native to the Mainland west coast. At his suggestion, specimens have been sent for further identification to Professor P. H. Timberlake at Riverside, California.

Glyptocolastes texanus Ashmead: This braconid wasp was first recorded in the Territory in 1950 as *Russellia* sp. ("Proceedings" 14(2):208, 1951). Several specimens were taken from light-trap catches during the past year, but its hosts are unknown. The determination was made by Dr. C. F. W. Muesebeck.

Microctonus vittatae Muesebeck: This braconid wasp was previously reported as *Microctonus* sp. ("Proceedings" 16(1):14, 1956). It is known to occur in Japan and the eastern United States, where it has been reared from beetles of the chrysomelid genus *Phyllotreta*. Related species have been bred from species of *Epitrix*, and *E. parvula* (Fabricius) is possibly a host in Hawaii. (Specimens were identified by Dr. C. F. W. Muesebeck.)

NEUROPRIA sp.: Specimens of this diapriid wasp were taken in a light trap at Ewa, Oahu, during 1956 and 1957 and were identified by Dr. C. F. W. Muesebeck. This is a new record for the Territory.

LYGOCERUS sp.: Dr. Muesebeck also identified this ceraphronid wasp to genus. Specimens were collected on the island of Hawaii by Dr. O. H. Swezey and labelled "*Megaspilus* sp.," but Dr. Swezey apparently never reported this find.

FLY TRAP: Dr. Joyce exhibited a simple type of fly trap made of readily available materials (a tin can, a glass jar, a standard jar ring, and some wire screen to make the funnel). He stated that this trap has proven very effective in collecting filth-inhabiting flies. The bait is held in the lower part of the tin can, from which the top has been removed. Slots are cut in the sides of the can about two inches from the bottom. A screen funnel is made to fit inside the jar ring, which is then placed on a standard pint or quart jar. The inverted jar then fits into the top of the can, which is three inches in diameter and about six inches tall.

Dr. Joyce reported taking the following two flies in Honolulu during June 1957 in traps baited with dead sparrows.

MUSCINA ASSIMILIS (Fallén): A specimen of this muscid was collected on June 27. Apparently this is a new island record, as the species has been reported previously only from Kamuela, Hawaii, where Dr. Hardy found it breeding in cabbage in March 1953 ("PROCEEDINGS" 15(2): 272, 1954).

CALLIPHORA VICINA (Robineau-Desvoidy): A specimen of this calliphorid, which appears to be rare in the Islands, was taken on June 13. It was first collected by Dr. Joyce in 1947 and 1948 ("PROCEEDINGS" 14(1):5, 1950) and apparently has not been taken in Honolulu since. Inasmuch as the fly was taken in the dock area, the present record may possibly be due to a reintroduction.

COLEOPTERA FROM MIDWAY ISLAND: Mr. Clagg reported the following identifications of beetles that were collected in rotten wood on Midway, May 23, 1957, by Mr. Meyer S. Bogost, Navy Special Assistant for Sanitary Engineering: *Alphitobius laevigatus* (Fabricius): Tenebrionidae, one specimen, determined by Mr. T. J. Spilman of the U. S. Department of Agriculture. *Dryophthorus* evidently *squalidus* Sharp: Curculionidae, four specimens, determined by Rose Ella Warner of the U. S. Department of Agriculture. This species is common throughout the Hawaiian Islands but has not been reported from Midway. Staphylinidae: one specimen, no specialist available.

TERMITES FROM WESTERN PACIFIC ISLANDS: Mr. Clagg presented the following notes on termites that were identified by Dr. T. E. Snyder at the U. S. National Museum.

PRORHINOTERMES INOPINATUS Silvestri: A widely distributed southern Pacific species previously reported from Guam (INSECTS OF GUAM 2:9, 1946), this form was found infesting a Navy laundry building on that island. According to Hill (TERMITES (ISOPTERA) FROM THE AUSTRALIAN REGION, pp. 136–139, 1942) it is normally found in rotten logs, and its invasion of buildings appears to be an unusual occurrence. The termites had built some 75 mud tubes from the soil up the inside of the concrete basement walls to reach the wooden portion of the structure. The inside of the basement, about 8 feet high, was very warm and humid due to many steam lines supplying the laundry equipment on the floor above. The mud tubes varied in height from only a few inches above the soil to others that reached the first floor. Several of the tubes were free-standing from the ground. However, none of these were more than 8 inches high. All of the tubes were narrow and fragile and crumbled very easily. Tubes built against the concrete walls were usually not built straight up but tended to wander over the surface. This was the only species of termite found infesting the building, and the tubes were quite dissimilar to those of *Coptotermes*.

COPTOTERMES FORMOSANUS Shiraki: This species was first found on Guam in Navy housing areas at Tipalao and later in other Naval areas near Apra Harbor and at Anderson Air Force Base near the northern end of the island. Dr. William W. Cantelo, entomologist for the Navy's Marianas Area Public Works Office, has written that *C. formosanus* is causing increasing damage on Guam each year, and he expects that infestations will in time become as widespread there as they are on Oahu.

On Midway Island, winged specimens of *C. formosanus* were first collected around lights during the summer of 1955 and again in the summer of 1956. On April 23, 1957, winged adults flew in open windows at the Bachelor Officers' Quarters, and an infestation containing all castes was located nearby the following day. In June 1957 two more buildings were found infested.

At Kwajalein Naval Station in the Marshall Islands, infestations of *C. formosanus* were first found in the wood of old building foundations in 1953 and were again collected in 1955 and 1956.

Mr. Davis presented the following notes:

CHLOROPS sp. **DAMAGING CITRUS:** On October 24, 1957, Mr. Nakao, Board of Agriculture and Forestry Entomologist and Plant Quarantine Inspector at Hilo, Hawaii, sent some injured rough-skin lemon seedlings for examination and identification of insect and other organisms working in the roots. The seedlings were grown at the Hilo Tree Nursery, and Mr. Nakao stated that approximately 85 percent of those in 100 flats were affected and that out of 600 seedlings in cans about 60 percent were affected. Flies reared from larvae in the roots were placed in the family Chloropidae by Dr. Hardy and subsequently in the genus *Chlorops* by Curtis W. Sabrosky of the U. S.

Department of Agriculture. Dr. Hardy stated that the larvae were working in live tissue and obviously damaging the roots and that damage by this species has not been previously recorded in the Territory.

ACHATINA FULICA Bowdich: On December 3, 1957, while releasing the carnivorous snail, *Euglandina rosea* (Férrusac), after a heavy rain on windward Oahu, Mr. Davis observed a giant African snail about 2 inches long swimming across standing water some 18 inches wide and 6 inches deep. The shell was horizontal on the water, the foot extended forward, and the head erect. The snail headed for an overhanging blade of grass and climbed it.

SYNGAMIA HAEMORRHOIDALIS Guenée: This pyralid moth was collected in Florida and Cuba early in 1956 and was released on Oahu, Hawaii, Maui, and Kauai between April and September ("PROCEEDINGS" 16 (2): 192, 314, 1957). It is now widely distributed on Oahu and Hawaii and is currently the most effective lepidopterous defoliator of lantana.

CATABENA ESULA Druce: Mr. Nakao found pupae of this phalaenid moth at two localities in Hilo and at Pahala, Hawaii, during November 1957, and adults have been taken in H.S.P.A. light traps on Oahu since August. These are the first recoveries of the moth, which was released in 1955 to control lantana ("PROCEEDINGS" 16(1):162, 1956).

Erratum: The note on *Macrosiphum granarium* (Kirby) presented by Dr. Hardy at the December 1956 meeting ("PROCEEDINGS" 16(2):197, 1957) was misstated. It should read: "Dr. Hardy stated that numerous alate specimens [not males] of the English grain aphid . . ."; and that part of the last line beginning with "but the new record . . ." should be deleted. Dr. Hardy adds that, to his knowledge, no male aphids have ever as yet been recorded in the Territory.—Ed.

The Endemic Genus Cillaeopeplus of Hawaii, with Descriptions of Two New Species (Coleoptera: Nitidulidae)

E. J. FORD, JR.

PLANT QUARANTINE DIVISION, AGRICULTURAL RESEARCH SERVICE, U.S.D.A.
HONOLULU, HAWAII

(*Presented at the meeting of October 14, 1957*)

Before 1908 all the endemic Hawaiian Nitidulidae were placed in the genus *Brachypeplus* established by Erichson in 1842 for some Australian nitidulids. Dr. D. Sharp established the genus *Cillaeopeplus* in 1908 (FAUNA HAWAIIENSIS 3:505–506) with three included species, two of them new and one previously described by him in *Brachypeplus*. There has been little new information on this genus since. In 1948 E. C. Zimmerman stated that *Cillaeopeplus* is a derivative of the SW. Pacific genus *Brachypeplus* (INSECTS OF HAWAII 1:82).

Cillaeopeplus Sharp

Cillaeopeplus Sharp, 1908, FAUNA HAWAIIENSIS 3:505.
Genotype: *Cillaeopeplus infimus* (Sharp) by present designation.

KEY TO SPECIES OF CILLAEOPEPLUS

1. Temples prolonged behind the eyes, forming a sharp angle.....2
   Temples not so prolonged.....**swezeyi**, n. sp.
2. Pronotum shining at the sides, with a large, dull, depressed area at the middle.....**dubius** Sharp
   Pronotum not shining at the sides, slightly or not at all depressed the middle, and rather uniformly dull.....3
3. Pronotum with the front angles sharply pointed and the side margins strongly serrate.....**staphyliniformis**, n. sp.
   Pronotum with the front and hind angles evenly rounded and the side margins feebly serrate.....4
4. Dorsum roughly sculptured; length 4 to 5 mm.; elytral striae rather deep and nearly as wide as the interspaces.....**perkinsi** Sharp
   Dorsum moderately sculptured; length 3.5 to 4 mm.; elytral striae moderately impressed and not nearly so wide as the interspaces.....**infimus** (Sharp)

Cillaeopeplus infimus (Sharp)

Brachypeplus infimus Sharp, 1878, TRANS. ENT. SOC. LONDON, p. 135.
Cillaeopeplus infimus (Sharp), FAUNA HAWAIIENSIS 3:506, pl. XIV, fig. 5, 1908.

First collected by Rev. Blackburn about 1878, *C. infimus* is by far the commonest species. Konahuanui Ridge, Oahu, 1893, R. C. L. Perkins; Lanai, 2000 ft., 1894, Perkins; Tantalus, Oahu, in *Pisonia*, 1906, Perkins; Tantalus, Oahu, 1800 ft., W. Giffard; SE. Koolau Range, Oahu, Feb. 1922, *ex Charpentiera*, O. H. Swezey; Tantalus, Oahu, *ex Pisonia*, July 1930, Swezey; Manoa, Oahu, F. X. Williams; Tantalus, Oahu, *ex Hibiscus*, April 1934, Swezey; Tantalus, Oahu, Dec. 1952, E. J. Ford, Jr.; Makua Valley, Oahu, June 1951, *ex* rotting kukui nut, Ford.

Cillaeopeplus perkinsi Sharp

Cillaeopeplus perkinsi Sharp, 1908, FAUNA HAWAIIENSIS 3:506.

I have examined specimens of this species from the Perkins collection at the Bishop Museum, Honolulu. It is known only from the original eight examples. Makaweli, Kauai, 2500 ft., Feb. 1897, R. C. L. Perkins.

Cillaeopeplus dubius Sharp

Cillaeopeplus dubius Sharp, 1908, FAUNA HAWAIIENSIS 3:506.

Described from a single male specimen. Kilauea, Hawaii, July 1895, R. C. L. Perkins. I now have an additional twelve specimens as follows: Mt. Kaala, Waianae Mountains, Oahu, 3000 ft., Dec. 1955, under bark of dying tree, E. J. Ford, Jr.

Cillaeopeplus swezeyi, new species (fig. 1, A)

Cillaeopeplus sp. probably *infimus* Sharp, Swezey, B. P. BISHOP MUS. SPEC. PUB. 44:71, 1954.

Male: Dorsum dark brown, nearly black, moderately punctured, somewhat shining. Head finely reticulate between the punctures which are separated by about three times their diameter; broadly depressed at the antennal insertions and evenly rounded inwards immediately behind the eyes. Pronotum with the reticulations more obvious than on the head; punctures prominent, with placement similar to those on the head; two very large punctures or pits at the middle just behind the front margin; side margins prominent and slightly roughened on the outer edge; front and hind angles evenly rounded. Elytra with prominent punctures in the striae; finely punctured interspaces obviously wider than the striae. Last abdominal segment swollen at the apex. Length, 4.5 mm.; width, 1.5 mm.

Holotype: Male, Paumalu, Oahu, June 22, 1935, *ex Dracaena*, R. L. Usinger. In the Bishop Museum, Honolulu, Hawaii.

Paratype: A single male apparently teneral, Paumalu, Oahu, June 16, 1935, *ex Dracaena*, O. H. Swezey. In the collection of the Hawaiian Sugar Planters' Association Experiment Station.

Named after Dr. Otto H. Swezey for his outstanding contributions to Hawaiian entomology.

This species differs from the others in the lack of a protuberance on each side of the head immediately behind the eye, and in the presence of two large pits on the middle of the pronotum near the front margin.

Cillaeopeplus staphyliniformis, new species (fig. 1, B)

Female: Dorsum dark brown, strongly roughened and dull. Head moderately depressed in front; tubercle behind the eye extending outward slightly beyond the outer margin of the eye. Pronotum entirely roughened and dull, flattened at the middle; side margins strongly serrate; hind margin shining at the middle; front and hind angles sharply pointed. Elytra with the striae as wide as the interspaces; striae deep with many fine punctures, giving a dullness which contrasts with the raised, somewhat shining interspaces; side margins parallel; apical half and side margins black; basal half brown at the middle. Length, 4 mm.; width, 1.3 mm.

Holotype: Female, Mt. Kaala, Waianae Mountains, Oahu, Dec. 1952, 3800 ft., E. J. Ford, Jr. In the Bishop Museum, Honolulu, Hawaii.

Distinct from other species in having the tubercle on each side of the head extending beyond the outer margin of the eye and in having prominent serrations on the side margins of the pronotum.

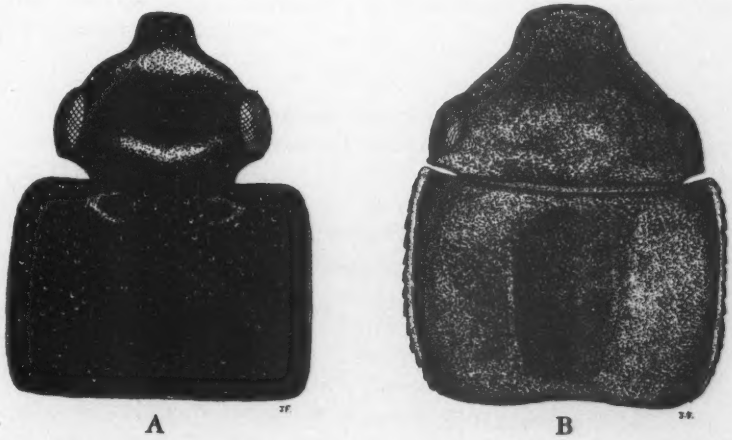


FIG. 1. Head and prothorax, dorsal view. A, *Cillaeopeplus swezeyi*, n. sp.; B, *C. staphyliniformis*, n. sp.

ACKNOWLEDGEMENTS

I am indebted to my wife for preparing the illustrations, and to the Hawaiian Sugar Planters' Association Experiment Station and the Bernice P. Bishop Museum for the loan of specimens.

A Key to the Proterhinus of the Island of Hawaii (Coleoptera: Aglycyderidae)

ELWOOD C. ZIMMERMAN

BRITISH MUSEUM (NATURAL HISTORY)
LONDON, ENGLAND

(*Presented at the meeting of November 18, 1957*)

In 1939 ("PROCEEDINGS" 10(2):339–341), I published a key to the *Proterhinus* weevils of the island of Hawaii, but because certain of the species were not represented in Hawaiian institutions, I was not able to include all of the species recorded from the island. In 1951, I checked several types at the British Museum and revised the key, and I believe that it is worthwhile to present it at this time.

In my previous report (1939:341) I called attention to the "variety" of *Proterhinus blackburni* which Sharp called *hystrix*, and I said, "It seems to me that there is little reason for maintaining the name *hystrix* as a 'variety' of *blackburni*. I cannot find reliable characters on the specimens in the FAUNA HAWAIIENSIS collection to separate the two supposed forms. *P. blackburni* is a variable species." I have now examined the types of *blackburni* and *hystrix*, and I find that the male and female types of *hystrix* are larger examples than the types of *blackburni*, but I believe them to be only possibly better fed individuals than the types of *blackburni*. I propose, therefore, to consider *hystrix* **a new synonym** of *blackburni*.

KEY

1. Humeri obviously (usually conspicuously) almost or quite acutely angulate, projecting forward around basal angles of prothorax 2

   Humeri not angulate and not projecting forward around basal angles of prothorax, but rounded off 15

2(1). Pronotum with long, or comparatively long, conspicuously erect, straight, or almost straight, spike-like setae in addition to depressed squamules; elytra bristling with even longer setae; a very spiny species (polyphagous) . . . **blackburni** Sharp.

   Pronotum without long, erect, straight setae, but with curved, decumbent, or subsquamiform setae only, at least never with erect setae on disc 3

3(2). Elytra with all or almost all of shorter setae erect and not squamiform, not forming distinct patches of condensed, prostrate,

subsquamiform setae except slightly on the scutellar callosities 4

Elytra with numerous, conspicuous patches of condensed, prostrate squamiform setae 5

4(3). Second elytral intervals comparatively deeply impressed in basal half, suture, therefore, appearing elevated; scutellar callosities distinct, but low; long setae quite dense on sides and declivity (on *Cibotium, Sadleria*) ..... **ferrugineus** Perkins.

Second elytral intervals not impressed, disc flattened, scutellar callosities obsolete; long setae rather sparsely scattered.... ..... **desquamatus** Perkins.

5(3). Lateral foveae of pronotum obsolete or very shallow (some *similis* may have them moderately developed and cause difficulty at this point) 6

Lateral foveae of pronotum distinct 8

6(5). Sides of pronotum without such a patch of dense squamules as described below; first elytral interval with squamules on basal fourth ..... **tarsalis** Blackburn.

Sides of pronotum from base to subapical constriction very densely clothed with a large patch of white and golden squamules that almost entirely hides the derm; first elytral interval bare of squamules in about basal fourth or less 7

7(6). Derm mostly testaceous and reddish, elytra with variable dark maculae ..... **similis** Blackburn.

Derm mostly black, elytra with only obscure reddish maculae ..... **ater** Perkins.

8(5). Scutellar callosities obsolete (on *Straussia*) .. **subangularis** Perkins.

Scutellar callosities distinct 9

9(8). Scutellar callosities strongly protuberant, tuberculiform..... ..... **hawaiiensis** Perkins.

Scutellar callosities not so developed 10

10(9). Humeri forming distinct obtuse angles; elytra with coarse raised and depressed areas ..... **vulcanus** Perkins.

Humeri either forming obviously acute angles, or only slightly obtuse (as on type of *affinis*), and then elytra not as in *vulcanus*; elytra variably sculptured 11

11(10). Eyes subtriangular, obviously conical; elytra with a single longitudinal costa representing the fifth interval, running from near posterio-lateral corner of scutellar callosity to apical third, without very conspicuous patches of condensed squamules. ..... **peles** Perkins.

Eyes more hemispherical than conical; elytra with conspicuous patches of condensed squamules 12

12(11). Dorsum for most part reddish, with only small areas dark.... ..... **rufescens** Perkins.
Dorsum usually for most part dark, but if elytra are mostly reddish, then pronotum at least dark.....13
13(12). Disc of elytra convex..... **gracilis** Sharp.
Disc of elytra distinctly and broadly flattened.....14
14(13). Sides and underside of rostrum with dense yellow beard; rostrum longitudinally, obscurely, finely carinate (rostrum appearing longer and more feminine than that of *affinis*)..... .....male type of **eurhynchus** Perkins.
Sides of rostrum with only sparse setae; rostrum without indication of fine longitudinal carinae..... .....male type of **affinis** Perkins.
15(1). Elytral sutural intervals rather distinctly elevated from base to declivity .....**tarsalis** Blackburn.
Sutural intervals not elevated.....16
16(15). With a conspicuous, pale, humeral patch of condensed squamules on elytron (be sure your specimens are clean).....17
Elytra without conspicuous pale humeral patches.....18
17(16). Elytra obviously impressed down middle and conspicuously maculate .....**hypotretus** Perkins.
Elytra convex and not at all impressed down middle and normally uniformly very dark throughout (on *Straussia*)..... ..... **subangularis** Perkins.
18(16). Antennae entirely very dark ..... **similis** Blackburn.
Antennae usually for most part reddish, at least basal segments reddish (polyphagous).....19
19(18). Lateral foveae on pronotum distinct and impressed..... ..... the type of **deceptor major** Perkins.
Lateral foveae on pronotum obsolete..... ..... the type of **deceptor konanus** Perkins.

Further study of adequate series may demonstrate that the two forms of *deceptor* are individual variants, but little more can be said at this time.

Some of the divisions of the key are weak, but they can only be strengthened by the study of additional material and use. Field work on Hawaii is especially needed.

Apion neofallax, a New Name for Apion fallax Wollaston (Coleoptera: Curculionidae)

ROSE ELLA WARNER

ENTOMOLOGY RESEARCH DIVISION, AGRICULTURAL RESEARCH SERVICE, U.S.D.A.
WASHINGTON, D. C.

(*Presented at the meeting of August 12, 1957*)

In 1845, Boheman described *Apion fallax* from South Africa (*in* C. J. Schönherr, GENERA ET SPECIES CURCULIONIDUM, tomus VIII, pars secunda, p. 370). In 1864, Wollaston described a new species from the Canary Islands and called it *Apion fallax* also (CATALOGUE OF THE COLEOPTEROUS INSECTS OF THE CANARIES IN THE COLLECTION OF THE BRITISH MUSEUM, p. 313). In 1910, Wagner (Apioninae. COLEOPTERORUM CATALOGUS, pars 6, pp. 27, 65) cited *fallax* Boheman as a valid species and *fallax* Wollaston as a variety of *violaceum* Kirby (TRANS. LINNEAN SOC. LONDON 9:65; pl. 1, fig. 16). In 1940, however, Uyttenboogaart (REV. FRANCAISE D'ENT. 7(fasc. 2):50) stated that *fallax* Wollaston is not a subspecies of *violaceum* Kirby.

Specimens collected by C. J. Davis in Rabat, Morocco, on April 23 and 28, 1957, on the leaves and in the stems of *Emex spinosa* Campd., were submitted to me for identification. After comparing specimens of *violaceum* Kirby and *fallax* Wollaston, identified by Wagner, I agree with Uyttenboogaart that *fallax* Wollaston is a good species. The species collected by Mr. Davis in Morocco is *fallax* Wollaston. From *violaceum* Kirby, *fallax* Wollaston can be distinguished by its coarser and denser pubescence, longer rostrum, finer punctation, and finally by the differences in the median lobe of the male genitalia.

A new name, *Apion neofallax*, is here proposed for *Apion fallax* Wollaston, 1864 (habitat in Lanzarota, Canaria, Teneriffa, Palma, and Hierro), which is preoccupied by *Apion fallax* Boheman, 1845 (habitat Port Natal).

The Green Scale, Coccus viridis (Green) (Homoptera: Coccidae), and Ants[1, 2]

HENRY A. BESS

HAWAII AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF HAWAII
HONOLULU, HAWAII

(*Presented at the meeting of December 9, 1957*)

There are many specific references to the association of ants with honeydew-producing insects (Nixon, 1951; Way, 1954) and to the interference by ants with the activity of parasites and predators of many homopterous insect pests (Flanders, 1951). During the academic year 1954–55, there was an opportunity to examine a number of natural infestations of honeydew-producing coccids, fulgorids, psyllids, and aphids in Ceylon and to follow experimentally the progress of *Coccus viridis* (Green) infestations attended and unattended by ants. The primary objective was to gain information as to how this scale and some other honeydew-producing insects benefit through attendance by ants. The possible association of parasite, predator, and pathogen activity with the population density of the scale was investigated in some detail, but the data and discussion of them will be presented in a separate paper. The present paper deals with the decline in numbers of this coccid in the absence of ants, and parasite activity with and without ants present.

METHODS

During the first several weeks after the author's arrival in Ceylon in May 1954, many ant-attended honeydew-producing insects, especially mealybug infestations on cacao, were examined to determine what species appeared to be dependent on ants and the activitiy of parasites in different infestations. At that time it was planned that intensive studies would be made with mealybugs on cacao and that extensive spraying to control ants would be done in plots within the plantations. However, the anticipated investigations in the cacao plantations did not prove feasible. In August, after many localized infestations of *C. viridis* attended by different species of ants had been observed on several different host plants, it was decided to make specific studies with this species and follow the progress of colonies with and without ants present. For the more intensive studies two series of experimental plots were used;

[1] Published with the approval of the Director of the Hawaii Agricultural Experiment Station as Technical Paper No. 408.

[2] This study was made possible through a Fulbright Award. The cooperation of the Department of Agriculture of Ceylon is also gratefully recognized.

one with branches on a large coffee tree, *Coffea arabica* L., and the other with orange plants, *Citrus sinensis* (L.), grown in bamboo pots.

The *C. viridis* on the coffee was a natural infestation tended by a vigorous colony of the large red ant, *Oecophylla smaragdina* Fabricius. After examining the colony at frequent intervals throughout August, it was found that the infestation appeared to be healthy, that there were several hundred scales per leaf, and that parasitization of adult scales was slightly below one per cent. On September 4, fourteen infested small branches, each with a dozen or more leaves on it, were selected and tagged. On the same date the main stems of one-half of the tagged branches were first wrapped with 3 to 4 layers of wax paper, over which 3 to 4 layers of paper toweling were applied. The wrappings were then tied in place with twine, and Dieldrin was applied with a brush. All ants on the branches distal to the bands were removed by hand. The bands were re-treated in the same manner with Dieldrin one week later and again on October 1. Without further treatments the bands effectively excluded ants until March 1955, when the study was concluded.

The 25 orange plants used in these studies were obtained from a nursery on July 26 and no *C. viridis* was found on them at that time. The plants were divided into two groups and placed close together around the bases of two trees (*Thevetia peruviana* (Pers.) K. Schum.), which were about 15 feet apart in the laboratory grounds. Each of the trees was infested with *Saissetia nigra* Nietner and attended by many individuals of the ant, *Technomyrmex albipes* (F. Smith). On the following day foliage and twigs infested with *C. viridis* were attached to the orange plants with paper clips. Numerous crawlers readily settled on the plants, and when the detailed studies on the progress of *C. viridis* on these plants were begun about two months later all of the plants were heavily infested. On October 1 the plants were divided into four groups, 6 in each of three groups and 7 in the other. Two groups were left in their original sites around the bases of the two trees with ants in attendance, while the other two groups were placed about 10 feet away under similar conditions. Ants were excluded from the two groups located a few feet away from the trees by first applying Aldrin to the ground and then applying Dieldrin with a brush in a band around each pot. All ants on these plants were carefully removed by hand. The pots were re-treated with Dieldrin on November 9 when one ant was found on a plant. No additional treatment was needed during the remainder of the study, which was concluded in March 1955.

At intervals of approximately two weeks, samples of 4 to 32 coffee and orange leaves were removed from each group of the experimental branches and plants and examined under a dissecting microscope. Counts were made of the scales by instars, and the second-instar larvae and adults were dissected. The number of scales which appeared to be diseased was also recorded and notes made on the relative amount of honeydew and sooty mold present.

In addition to the above series many collections of *C. viridis* and other

coccids were made in other localities on different hosts attended by different species of ants. Usually only the adults in these collections were dissected to determine the degree of parasitization. The progress of *C. viridis* and parasitization was also followed on a large tree, *Gliricidia sepium* (Jacq.) Steud., on the laboratory grounds by periodically making spot collections of leaves from it, counting the number of adults present, and dissecting them for evidence of parasites and disease.

Results

In less than 24 hours after the attendant ants were excluded from the experimental coffee branches and orange plants infested with *C. viridis* the leaves became sticky with honeydew and took on a glistening appearance, which increased throughout the first week. Honeydew accumulated rapidly on the ant-free coffee leaves, with droplets on many scales actually larger than the scales themselves. Within a week sooty mold began to increase appreciably on the ant-free leaves; however, many scales appeared to remain healthy. In the meantime, on the leaves with ants present there was little or no accumulation of honeydew, and very little sooty mold. By the end of the second week sooty mold had become very abundant on the ant-free coffee foliage, with many scales covered with sooty mold. On the orange plants the development of honeydew and sooty mold was essentially the same as that on the coffee branches except that sooty mold developed faster on the orange plants, which was possibly due to the wetter weather in October than in September.

The scale populations, both on the coffee branches and on the orange plants, decreased and finally disappeared where ants were excluded (table 1). At the time the first samples from the coffee branches were examined on the 17th day after ants were excluded, about 35 per cent of the first- and 55 per cent of the second-instar larvae were dead on the ant-free branches, while only 10 per cent of the first- and less than 5 per cent of the second-instar larvae on the branches with ants were dead. Similar conditions prevailed two weeks later when over 50 per cent of both the first- and second-instar larvae in the samples from ant-free branches were dead, while only about 5 per cent of those on branches with ants were dead. Throughout the period of study the mortality rate among all stages was higher on the ant-free coffee branches and orange plants than on those which had ants present (table 2). Furthermore, the infestations of *C. viridis* on each of the 7 ant-free coffee branches and the 12 ant-free orange plants completely disappeared in about four months, while the ant-attended infestations were still in a healthy condition.

The possible interference of ants with parasites of the scale was followed rather closely through periodic examination and dissection of samples of adult scales. Most of the parasitization within the experimental infestations was caused by the eulophid parasite, *Aneristus ceroplastae* Howard, which attacks adult scales primarily; therefore the data presented on parasitization in

these infestations relate only to the adult stage. At first glance the percentage parasitization without ants present appeared to be higher than when ants were present (table 3). However, if parasitization is calculated on the basis of total number of scales in the samples taken from the citrus plants between October 28 and February 9 it was slightly higher (22 to 18) on the plants with ants than on the ones without ants. Furthermore, there were also more parasitized scales per leaf on the plants with ants present. On the same basis, the percentage parasitization was higher on the ant-free coffee branches (21 to 9). However, there were more parasitized scales per leaf in the samples from branches accessible to ants.

A few examples will suffice to show that in some instances parasites were quite successful in natural infestations in the presence of ants. On January 27 and 30, seventy-three adult *C. viridis* from a citrus tree about 100 yards from the laboratory were dissected, and 56 per cent of them were parasitized by an undetermined external parasite (probably a cecidomyiid, but no adults were obtained). During the next several days additional samples of the scale were obtained from a nearby coffee tree and a sapodilla tree, *Achras sapota* Mill., which were also attended by *T. albipes*. Seventeen, representing 77 per cent, of the 22 adult *C. viridis* taken from the coffee tree on February 5 and 9 were parasitized, and all of the 13 adults in the samples taken from the sapodilla tree on February 7 and 9 were parasitized. Two hundred eighty-eight, or 70

TABLE 1. Progress of *C. viridis* infestations on experimental plants with and without ants.

DATE	NUMBER LIVE SCALES PER LEAF	
	WITH ANTS PRESENT	WITH ANTS EXCLUDED[1]
	COFFEE	
9-23-54	1300	530[2]
10-10-54	1100	480
10-26-54	530	250
11-12-54	250	55
11-29-54	380	8
1-3-55	220	+[3]
2-2-55	200	0
	CITRUS	
10-2-54	160	
10-28-54	210	240
11-18-54	290	54
11-30-54	440	33
1-10-55	220	+[4]
2-9-55	27	0

[1] Only more heavily infested leaves were taken as samples; therefore, the infestations actually declined much more rapidly than these figures indicate.

[2] Ants excluded from coffee twigs on September 4 and from citrus plants on October 1.

[3] One living out of a total of 260 scales on 10 leaves.

[4] Three alive out of a total of 25 scales on 32 leaves.

per cent of the 414 second-instar *C. viridis* in these samples from the coffee tree were parasitized; and 190, or 81 per cent, of the 234 second-instar *C. viridis* in the samples from the sapodilla tree were parasitized. Individuals of *T. albipes* were numerous on both of these trees.

Discussion

The *C. viridis* infestations on the experimental coffee branches and orange plants from which ants were excluded declined rapidly during the first few weeks and disappeared completely within about four months; however, the infestations attended by ants were still thriving when the study was closed in March 1955. The decline in the ant-free infestations was actually much more rapid than indicated by the data presented in table 1, for as the scale population declined and became more spotty in distribution only more heavily infested leaves were selected as samples from the ant-free branches and plants. There was a higher percentage of the scales dead among those without ants in attendance than among those attended by ants, and this was pronounced in each developmental stage (table 2). The mortality among the ant-free scale infestations was approximately 4 times that among the ant-attended ones. The gradual rather than abrupt disappearance of the infestations on the ant-free branches and plants may be significant from a population dynamics standpoint. Unfortunately, the growth rate of individual scales with and without ants in attendance was not determined; however, Van der Goot (1916) found that ant-attended individuals developed to maturity in 65 days, while unattended individuals required 83 days.

The actual cause of death of the scales was not determined, except for those which contained parasites, parasite emergence holes, or conspicuous evidence of being infected with bacteria or fungi. Within a few hours after the ants were excluded, droplets of honeydew began to accumulate on the

Table 2. Summary of mortality in different stages of *C. viridis* when attended and non-attended by ants[1]

Stage	With ants present		With ants excluded	
	No. scales in samples	Per cent dead	No. scales in samples	Per cent dead
		Coffee		
First	9708	11	3347	45
Second	1505	19	2446	53
Adult	1012	12	506	51
		Citrus		
First	6025	2	865	8
Second	2069	7	486	25
Adult	931	31	513	34

[1] Based on scales present at time samples were examined.

scales and foliage, and this was followed by an abundant growth of sooty mold. Both the honeydew and sooty mold might well have had an adverse effect on the scales in hindering them mechanically and otherwise upsetting their well-being. The dense growth of sooty mold appeared to interfere with crawlers in settling; and it is possible that some scales died as a result of becoming overgrown with sooty mold, as many living scales became densely covered. The indirect benefits derived in this manner from the ants could be classed as primarily sanitational. It is also possible that the dense growth of sooty mold adversely affected the nutritional qualities of the sap on which the scales fed, but this was not investigated.

During these studies no ant was seen to attack or transport a living scale; however, in several instances ants were seen transporting bits of wax from mealybugs.

Ants are known to interfere with some parasites and predators of certain coccids. However, during these studies ants were not observed molesting parasites or predators, and there was little evidence obtained to indicate that ants adversely affected the parasites of *C. viridis*. The percentage parasitized was somewhat higher in the ant-free infestations on the experimental coffee branches; but the number of parasitized scales per leaf was about the same as in the ant-attended infestations, and there was even less evidence of an adverse effect from ants on the parasites in the infestations on orange plants (table 3).

Furthermore, in several field collections of scales attended by ants, including species other than *C. viridis*, between 50 and 90 per cent of the individuals

TABLE 3. Parasitization of *C. viridis* adults with and without ants present.

DATE	WITH ANTS PRESENT			WITH ANTS EXCLUDED[1]		
	No. scales per leaf	No. scales parasitized per leaf	Per cent parasitized	No. scales per leaf	No. scales parasitized per leaf	Per cent parasitized
			COFFEE			
9-23-54	74.5	0	0	31.0	0.5	2
10-10-54	40.0	7.0	18	22.0	10.5	48
10-26-54	23.2	4.2	18	6.8	5.0	74
11-12-54	121.2	0.8	1	43.8	5.0	11
11-29-54	30.0	11.2	38	2.2	1.5	56
1-3-55	5.5	0.8	14	0		
2-2-55	14.5	1.5	10	0		
			CITRUS			
10-28-54	38.0	3.0	9	61.5	4.5	7
11-18-54	40.0	3.5	9	22.5	7.2	32
11-30-54	27.1	8.5	31	7.3	2.5	34
1-10-55	14.9	3.7	25	+[2]	+[2]	100
2-9-55	10.5	5.8	55	0		

[1] Ants excluded from coffee twigs on September 4 and from citrus plants on October 1.
[2] Only 1 scale on 32 leaves and it was parasitized.

were parasitized. In a number of instances scales were collected and dissected to determine whether parasitization was higher on the leaves than on the stems, and on leaves outside *O. smaragdina* nests than on leaves inside them. No clear-cut differences were found in either case. Parasitization in excess of 50 per cent occurred on stems which served as runways for ants attending scales on trees, and parasitization was no higher on the leaves than on the stems.

Summary

Individual colonies of the green scale, *Coccus viridis* (Green), gradually but completely disappeared in about four months after ants were excluded from them, while ant-attended colonies continued to thrive. No satisfactory answer was obtained to the question of how the scales were aided or protected by the ants. However, there was very little or no evidence obtained to indicate that the ants reduced parasite and predator attack. In several instances well over 50 per cent of the scales in ant-attended colonies were parasitized.

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Recent Introductions for Biological Control In Hawaii-III[1]

C. J. Davis

BOARD OF AGRICULTURE AND FORESTRY
HONOLULU, HAWAII

(*Presented at the meeting of December 9, 1957*)

This paper is a check list of beneficial organisms released in Hawaii by the Board of Agriculture and Forestry since the last published listing by Weber ("Proceedings," 16(2):313–314, 1957.)

Three categories of biological control are encompassed, namely, snail, plant, and insect pests. Organisms marked with an asterisk were previously introduced.

Summary

I Snail Pest Control

Of the ten insect and snail predators released, the most promising control for *Achatina fulica* Bowdich appears to be *Euglandina rosea* (Férrusac). This carnivorous snail was introduced in 1955 from Florida, where it preys on the citrus tree snail, *Drymaeus dormani* Bienny. It is well suited to climatic conditions in Hawaii and 2,483 individuals were recovered from Hauula and Makiki, Oahu in December 1957. It feeds voraciously on infant and juvenile African snails but will attack *Achatina* up to 40 millimeters in length. Worthy of note is its fondness for *Bradybaena* (*Eulota*) *similaris* (Férrusac), the destructive garden snail.

Gonaxis quadrilateralis (Preston) has been found at all release points on Oahu, but proper evaluation is not practical at this time.

Gonaxis kibweziensis (Smith) was introduced previously and is established at several Oahu release points but apparently has not spread and multiplied as it did on Agiguan, Marianas Islands. There are indications, however, that it is doing well on Maui.

II and III Plant and Insect Pest Control

With the exception of *Aerenicopsis championi* Bates, a branch-boring cerambycid previously introduced from Mexico for *Lantana camara* L., none of the insects reported for the control of listed plant and insect pests have been recovered to date. Most of the insects were recent releases.

[1] This paper is a continuation of a series commenced in 1951 by the late Philip W. Weber. The title was previously changed to include groups other than insects.

New Introductions and Additional Releases for Biological Control in Hawaii

PEST NEEDING CONTROL	ORGANISM INTRODUCED	SOURCE	COLLECTOR	DATE OF RELEASE (1957)	**RELEASE POINT
I SNAIL PESTS					
Achatina fulica Bowdich . . . . (giant African snail)	**Gulella wahlbergi* (Krauss)	Durban, South Africa	N. L. H. Krauss	Jan. 2	Maui: Haiku Oahu: Nuuanu
	**Euglandina rosea* (Férrusac)	Delray Beach, Florida	Klemann	Feb. 9	Oahu: Hauula
	**Gonaxis kibweziensis* (Smith)	Diani and Tiwi Beaches, Mombasa, Kenya, Africa	N. L. H. Krauss	May 4	Oahu: Kaneohe
	**Tefflus zanzibaricus alluaudi* Sternberg	" " "	" "	" "	Oahu: Kaneohe
	Tefflus purpureipennis wituensis Kolbe	" " "	" "	" "	" "
	Thermophilum hexastictum Gerst	" " "	" "	" "	" "
	**Oleacina oleacea straminea* (Deshayes)	Cuba	A. Thistle	May 26	Oahu: Hakipuu
	Edentulina affinis C. R. Boettger	Diani Beach, Mombasa, Kenya, Africa	N. L. H. Krauss	June 5	Oahu: Haiku Valley Road
	Gonaxis quadrilateralis (Preston)	Kwale, Kenya, Africa	N. L. H. Krauss	June 16	Oahu: Makiki Maui: Paia, Haiku
	**Lamprophorus tenebrosus* (Walker)	Gurudeniya near Kandy, Ceylon	N. L. H. Krauss	Aug. 14	Oahu: Haiku Valley
Subulina octona Bruguiere . . . (conical snail)	*Gulella bicolor* Hutton	Manila, Philippine Islands	N. L. H. Krauss	Oct. 10	Oahu: Haiku Valley and Tantalus

* Previously introduced.
** Applies to initial releases only.

New Introductions and Additional Releases for Biological Control in Hawaii

PEST NEEDING CONTROL	ORGANISM INTRODUCED	SOURCE	COLLECTOR	DATE OF RELEASE (1957)	**RELEASE POINT
II PLANT PESTS					
Emex australis Steinh.	*Apion antiquum* Gyllenhal	Durban, South Africa	N. L. H. Krauss	Jan. 2	Hawaii: Parker Ranch, Waimea
Emex spinosa Campd. (emex)					
Lantana camara L. (lantana)	*Hypena jussalis* Walker	Diani Beach, Mombasa, Kenya, Africa	N. L. H. Krauss	May 10	Oahu: Tantalus Hawaii: Pahala
	**Aerenicopsis championi* Bates	Vera Cruz, Mexico	A. Thistle	May 13	Hawaii: Magoon Ranch, South Kona
III INSECT PESTS					
Aphis sp.	*Alesia striata* Fabricius	Kenya, Africa	N. L. H. Krauss	May 21	Oahu: Moanalua
Spodoptera mauritia (Boisduval) (armyworm)	*Calosoma* sp.	Kenya, Africa	N. L. H. Krauss	May 29	Oahu: Mahinui Place, Kaneohe Hawaii: Parker Ranch, Waimea
Maruca testulalis (Geyer) (bean pod borer)	*Bracon cajani* Muesebeck	Mauritius	A. Moutia	Aug. 16	Oahu: Haiku Valley
Protaetia fusca (Herbst) (scarab beetle)	**Campsomeris annulata* (Fabricius)	Yigo, Guam	N. L. H. Krauss	Oct. 26	Oahu: Koko Head and T.H. Hospital, Kaneohe
Heliothis zea (Boddie) (corn earworm)	*Chelonus narayani* Rao	New Delhi, India	G. Angalet	Nov. 11	Oahu: Waimanu
Siphona irritans (L.) (horn fly)	*Geotrupes* sp.	Northern Iran	E. Esfandiari	Dec. 24	Oahu: Kualoa

NOTE: Scarabaeidae (dung beetles) and Histeridae (hister beetles) from China and Africa were received, but these are pending identification and will be reported later.

* Previously introduced.

** Applies to initial releases only.

Importations of Natural Enemies of the Weed, Emex spinosa Campd.

DAVID T. FULLAWAY

BOARD OF AGRICULTURE AND FORESTRY
HONOLULU, HAWAII

(*Presented at the meeting of December 9, 1957*)

The polygonaceous weedy herb, *Emex spinosa* Campd., is supposed to have been introduced unintentionally many years ago with grass seed from Australia. Its presence in our pastures was duly reported by economic botanists, and since it is a heavy seeder and produces its seed in a spiny bur which cattle pick up on their feet and spread, its harmful potentialities were realized and ranchers were advised to hoe it out before it seeded. This, however, was not done, and it was only when it was observed that the weed was taking over fairly large areas of pasture on the Parker Ranch, on the island of Hawaii, the largest ranch in the Territory and most efficiently managed, that measures were initiated to suppress it. This was about 1940. The plant is also prevalent on ranches on Oahu, Molokai, Maui, and Lanai.

The first efforts at control were more or less tentative. Emex, being an annual, comes up from seed in the ground after the first rains in October and by January or February has attained sufficient size to be noticeable in a pasture. The aim was to destroy by hoeing as many plants as could be reached, before they produced seed. As the weed was thickest where there were bare spots, as along trails or around water troughs where cattle congregated and tramped down the grass, these areas received the most attention. At the same time chemical treatment was applied experimentally to other areas. 2,4-D was used and CMU also. The latter proved more effective than the former. Later, in the worst infested areas, the ground was plowed and kikuyu grass (*Pennisetum clandestinum* Hochst.) planted to suppress the emex.

Simultaneously, a project was set up to see what could be done in the way of biological control. As the plant was said to be a native of the Mediterranean basin, investigations were begun in Italy and Sicily in 1950 and carried on from March to August by Dr. Russo of the Portici laboratory with his assistants. They found that *Lixus algirus* L. developed in *Emex* in this region but also attacked *Vicia faba* L. (the broad bean) and other plants. For this reason it could not be used, and as nothing else of promise was discovered, the investigation was discontinued. But the following year we learned by correspondence with Dr. Grillot, Chief of the Agricultural Experimentation Service of Rabat, French Morocco, that emex plants are attacked by a fungous disease in Morocco, determined as *Peronospora rumicis* Cord.; further, that the

plant is attacked by an aphid, *Anuraphis eruices* Mimeur (which also attacked beets, we were informed); and that the leaves are mined by the larvae of an anthomyiid fly, *Pegonia bicolor* Wiedemann. Later, as one of the California State entomologists, Dr. Robert Van den Bosch, was exploring for beneficial insects in North Africa, we requested him to investigate and determine the damage done by these to the plant. Unfortunately, when he was at Rabat, the plant was dormant. It was also learned somewhat later from California entomologists that emex found in Anaheim is attacked by *Gastroidea cyanea* Melsheimer, the green dock beetle—a chrysomelid, which feeds on the leaves but is not considered a very effective enemy; and that *Lixus mucidus* Leconte, reared from *Rumex* (dock) would be a possible enemy also. However, the introduction of these insects for testing was not approved, mainly because they lacked specificity.

Another approach to the problem presented itself. *Emex australis* Steinh. is reported present in South Africa and Australia. Some botanists consider the two species identical. Correspondence with entomologists in the two countries elicited no information with regard to insects or diseases attacking the plant in the Southern Hemisphere. But field collector Noel L. H. Krauss of the Board of Agriculture and Forestry undertook on his African expedition in 1956 to investigate for himself and in December found a stem-boring larva in *Emex australis* in Durban which he shipped to us as advanced larvae in the stems. Shipment of infested stems continued through January, February, and March 1957, and large numbers of *Apion antiquum* Gyllenhal were reared. The weevil proved easy to propagate and, as it is believed to be specific, liberations have been made on the different islands where emex is present. *Apion antiquum*, we are assured by Mr. Krauss, is not known as a pest of any cultivated plant grown in South Africa and is not known to attack any other plant than emex. Experiments made with it in the course of testing indicate that it is a very effective enemy, as it kills all stems to the ground and has a fairly rapid development, a generation lasting about one month. How it will bridge the dry season when emex is more or less dormant is not known. Mr. Krauss informs us that nothing is known of its biology in South Africa. As a matter of fact, its host was unknown until he bred it from emex. There were other insects collected on emex in South Africa: one, a lepidopteron feeding on the leaves, was shipped in but failed to perpetuate itself; another weevil, *Sciobius brevicollis* Fåhraeus, was not sent in, as it is known to attack other plants than emex; and another unidentified weevil of which so few examples were sent that there was no hope of propagating it.

It is believed, however, that with *Apion antiquum* alone we will have an effective control.

Lately C. J. Davis, one of our entomologists, has been in Morocco and was able to collect and ship us stems of emex containing *Apion violaceum* Gyllenhal. This insect has not been released; it is still being tested as to specificity.

Ants Attracted to Naphthalene on Malaita[1]

J. Linsley Gressitt

BERNICE P. BISHOP MUSEUM
HONOLULU, HAWAII

(*Presented at the meeting of December 9, 1957*)

On the island of Malaita, British Solomon Islands, the ant *Iridomyrmex myrmecodiae* Emery was attracted to naphthalene in very large numbers. This small ant is of importance to coconut and other palms and also to other plants, such as cacao, as well as to the *Myrmecodia* plant which provides cavities in which the ant nests. In the Solomons this ant drives from the palms beneficial ants such as *Anoplolepis longipes* (Jerd.) and *Oecophylla smaragdina* (Fabricius), which reduce populations of the coreid bug, *Amblypelta coccophaga* China, which causes coconut nutfall. This ant is a vicious biter and is disliked as much as, or more than, the *Oecophylla* by those who climb coconut palms.

At Auki on the west coast of Malaita, during September 18–22, 1957, *Iridomyrmex myrmecodiae* was invading a concrete and cement-brick house in great numbers, attracted to insect and plant specimens in various stages of sorting and drying when these were not over the drying fire. Lindane powder, chlordane emulsion, and naphthalene were used to combat or repell the ants. The naphthalene was of two brands, one white, brought from Honolulu, the other pink, obtained at Honiara; and both were in flake form. Naphthalene was put with all the insect specimens layered in cellucotton in pill boxes and cigar boxes, and it was noticed that the ants entered these when lindane was not sprinkled about. Also, it was noticed that the naphthalene containers and spilled naphthalene attracted many ants. Then tests were made, with both kinds of naphthalene, to test whether naphthalene alone actually attracted the ants. A book case top and a table top were completely cleared and cleaned and naphthalene was placed on them in the bottom of otherwise empty, new sliding pill boxes slightly open at one end. These continued to attract ants until one pill box was nearly full of dead ants, estimated at 10,000 in number, or about ten times in bulk the amount of naphthalene in the pill box. Also, naphthalene was thinly sprinkled on parts of the table tops. The naphthalene alone constantly attracted ants, which would pick up flakes of naphthalene in their jaws, wander about a few moments, and then fall and die until there were great numbers of dead ants on the table tops. By application of the chlordane

[1] Partial results of the project "Zoogeography of Pacific Insects," supported in part by a grant from the National Science Foundation.

emulsion at bases of doors and windows, large piles of dead ants accumulated, both inside and outside, adjacent to the walls. These piles included over one million ants. *Myrmecodia* plants were abundant on trees about the house, which was on the top of a small hill partly covered with secondary forest.

In the meantime a large pill box nearly full of pink naphthalene, stored in a cupboard, was invaded by such numbers of ants that the box had to be placed very near the drying fire to keep further ants away, and the ants that entered the box became inseparably mixed with naphthalene.

During a trip into the interior of Malaita, when the drying fire was discontinued, ants entered the boxes of partially dried specimens containing naphthalene and died there, requiring a further clean-up and drying.

After lindane was mixed with the naphthalene, no further serious trouble was had with the ants, in the interior or on return to Auki.

It should be noted that this ant did have the tendency to continue to come to a place where food had been, but had been cleaned up. However, it did not continue to be so attracted ceaselessly as it did to naphthalene, and did not enter empty boxes in numbers.

Though the same ant is abundant on Guadalcanal and Bougainville, as well as New Britain, it was not found to be attracted to naphthalene or into houses in the manner experienced on Malaita. Residents of Auki stated that the new concrete houses are badly invaded by this ant, whereas the old wooden houses are not invaded. Phillips (BULL. ENT. RES. 47(3):575–595, 1 pl., 1956) notes the superabundance of this ant on Malaita, correlating with the worst coconut nutfall picture in the Solomons.

I am indebted to Mssrs. C. Jack-Hinton, B. W. Stone, and H. Roberts for help in dealing with the ants at Auki.

Trapping of Air-borne Insects on Ships on the Pacific[1]

J. LINSLEY GRESSITT and SETSUKO NAKATA

BERNICE P. BISHOP MUSEUM
HONOLULU, HAWAII

(*Presented at the meeting of December 9, 1957*)

As a phase of the project "Zoogeography of Pacific Insects" a start was made during the summer of 1957 in trapping of air-borne insects at sea. Through the cooperation of officials of the U. S. Navy and the Military Sea Transportation Service, traps have been placed on military transport ships sailing from Honolulu to San Francisco and to Guam and Manila. The object of this phase of the program is to test the theories of natural air dispersal of insects to isolated Pacific islands and to coordinate data with information on present and past air currents in the Pacific area. We acknowledge the assistance and advice of Roy L. Fox and David Blumenstock of the U. S. Weather Bureau at Honolulu, and Kenneth L. Maehler and Ivan Rainwater of the federal plant quarantine at Honolulu. We are also indebted to the California Spray Chemical Corporation and the Tanglefoot Company for sample materials of "deadline" and "tanglefoot," respectively. Harold Toba assisted with the work during part of the period reported, as did Carl Isenberg.

The type of trap used was planned to catch insects travelling passively in air currents or dropping from higher air currents. Each trap consists of a metal frame in form of a cube, with five removable aluminum screens, each one-fifth of a square meter in area, and fitting in the top and four sides, respectively of the cubical frame, so that all sides and top are effective trapping surfaces for all types of weather. The five screens are painted with an adhesive material such as a resin-castor oil (see Glick, U. S. DEPT. AGR. TECH. BULL. 673, 1939), "deadline," or "tanglefoot," and new screens are substituted every 24 hours during cruises, except for cruises to the Philippines in which screens are exposed for 48 hours. Resin-castor oil mixture was used for the first 2 cruises to San Francisco, but for all other cruises a mixture of "deadline" and resin-castor oil was used since the latter proved a better adhesive. Each trap is accompanied by a metal box containing 45 extra screens fitting into slots to keep them separate, so that the screens may be searched for adhering insects when the ship returns to Honolulu. The 50 screens permit operating the trap for ten 24-hour, or 48-hour, periods during a single cruise. The trap is not put into operation until the ship is approximately 18 to 24 hours out of port,

[1] Partial results of the project "Zoogeography of Pacific Insects" supported in part by a grant from the National Science Foundation.

Records of ship trappings of air-borne insects
Arrows indicate that trapping was done going in both directions on each cruise.

TABLE I

24-hr. periods of trapping at sea	→	→	→	→	→
HONOLULU	←	←	←	←	SAN FRANCISCO ←
W. Longitude (av. of 4 cruises)	152°–147°	147°–141°	141°–135°	135°–129°	129°–122°
Corrodentia	1				1
Thysanoptera		1			
Diptera					
Tendipedidae					2
Coleoptera					
Anthribidae			1[1]		
Hymenoptera					
Formicidae	1				

[1] The anthrihid taken midway between Honolulu and San Francisco presumably came from inside the ship

TABLE II

48-hr. periods of trapping at sea	←	←	←	←	←
PHILIPPINE IS. (via Guam)	→	→	→	→	HONOLULU →
E. Longitude (av. of 2 cruises)	124°–139°	139°–150°[1]	150°–165°	165°E–178°W	178°W–161°W
Araneida	1	1			
Corrodentia		1		1	
Diptera					
Heleidae	15	68+		1	
Sciaridae		19			
Phoridae		2			
Drosophilidae (?)		4			
Chloropidae		2			
Scatopsidae		1			
Lauxaniidae		2			
Coleoptera					
Chrysomelidae		1			
Coccinellidae		1			
Staphylinidae		1			
Family (?)					1
Hymenoptera					
Chalcidoidea	7	19			
Formicidae		1			
Family (?)		1			

[1] Column 2 includes trappings while in port at Guam.

but this was apparently overlooked for Guam on the long cruises. Three sets of traps and screen-boxes have been in operation, besides a check trap operated on the roof of the Bishop Museum at Honolulu.

One microlepidopteran was recorded between Longitude 162°08′W and 168°33′W from a trap which was set on a separate cruise to Kwajalein Atoll.

From a brief examination of the Corrodentia by E. L. Mockford, the specimen found on the screen near the port of San Francisco appears to be a species present on the coast of California, and the other specimen recorded near the port of Honolulu appears to be a Hawaiian form.

The data thus far at hand are very meager, and some years of trapping will be required before much significant data can be accumulated. The records to date show a higher representation of small, weak-flying insects, and more records closer to land, as was expected.

A Review of the Genera Sophira Walker and Tritaeniopteron De Meijere (Diptera: Tephritidae)[1]

D. Elmo Hardy

HAWAII AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF HAWAII
HONOLULU, HAWAII

(*Presented at the meeting of December 9, 1957*)

Tritaeniopteron de Meijere has been previously treated as a synonym of *Sophira* Walker but I am now convinced that these are distinct genera. While studying at the British Museum (Natural History) and in various European Museums in 1954 I had an opportunity to study the existing types of most of the species and I believe I have examined the big majority of the specimens of these groups which have been collected to date. The following report is based upon this study.

Genus Sophira Walker

Sophira Walker, 1857, Jour. Proc. Linn. Soc. London 1:35.

Predominantly rufous to yellow flies characterized as follows: scutellum with six marginal bristles; the presutural bristles present and the sternopleural bristles absent; wings subhyaline to yellowish fumose with at least some fumose markings along the costa or along some of the veins; 3rd costal cell elongate, distinctly longer than the 2nd, vein R_1 extends approximately to a level with the m crossvein; vein R_{2+3} straight; two pairs of inferior fronto-orbital bristles situated on the lower part of the front, the first pair is smaller than the second; two pairs of superior fronto-orbital bristles present and the arista of the antenna long plumose. The secondary scutellar bristles are distinct but vary in size from approximately one-third to two-thirds the size of the other bristles. Shiraki (Mem. Fac. Sci. Agr. Taihoku Imp. Univ. 8:320, 1933) characterized *Sophira* as having all the bristles yellow and the wings with three oblique bands. The latter would pertain to *Tritaeniopteron* but the color of the bristles is a specific rather than a generic character. Most species do have yellow to rufous bristles but some have them brown to black.

The genus *Sophira* is still very poorly known and is rare in collections. Eleven species and one subspecies (this should probably be a variety) fit my concept of this genus. Two of the species which have been previously treated as *Sophira* are herein placed in the genus *Tritaeniopteron*. Of the recognized

[1] Published with the approval of the Director of Hawaii Agricultural Experiment Station as Technical Paper No. 412.

Sophira seven species are known only from unique females; both sexes are known for only one species; and one species is known only from a unique male.

As now known the genus is apparently confined to the southwest Pacific and Malaya, except for one species from northeast India.

Type of the genus: *Sophira venusta* Walker.

KEY TO KNOWN SPECIES OF SOPHIRA

1. Wings with four longitudinal brown streaks, one along costa and one along each of veins R_{4+5}, M_{1+2} and M_{3+4} (fig. 2, B) (Malaya and Indonesia) ..... **venusta** Walker
   Wings not as above 2
2. A broad longitudinal band of brown extends diagonally from apex of cell R_5 basad along vein M_{1+2} across the m crossvein through cell M_4 to apex of cell Cu (figs. 1, F, and 1, I) 3
   No such longitudinal band extending to cell R_5 6
3. Wing margin brown from about middle of cell M_4 to base of cell Sc (fig. 1, F) 4
   At least apex of cell 2nd M_2 and a portion of the apex of cell R_3 paler colored than the brown markings (figs. 1, E, and 1, G) 5
4. Tibiae dark brown to black. Hind portion of mesonotum polished black. A shining black stripe extends over pleura from sternopleura over the mesopleura; this extends onto the dorsum in front of the suture and almost connects with the submedian black, longitudinal vittae. Cell 2nd M_2 entirely brown, cell R_1 largely brown (fig. 1, F) (Formosa) ..... **limbata** Enderlein
   Tibiae reddish brown. Mesonotum reddish brown just in front of scutellum. Pleura reddish brown, with no shining black stripe. Cell 2nd M_2 with a yellow spot in the middle, cell R_1 largely yellow; the brown costal band extends part way along veins R_{2+3}, R_{4+5} and M_{1+2} (fig. 1, I) (India) ..... **phlox** Munro
5. Apex of cell R_3 largely brown. Second costal cell brown (fig. 1, E) (Java) ..... **insueta** Hering
   Apex of cell R_3 and second costal cell without brown fumosity (fig. 1, G) (Borneo) ..... **limbata borneensis** Hering
6. Thorax entirely yellow to rufous 9
   Thorax with some black markings on the mesonotum 7
7. Wings with no dark brown band extending around apex and with a dark spot on vein M_{1+2} between the crossveins, or with a dark mark extending over the m crossvein 8
   Wings with a narrow brown band extending around costa from base of the subcostal cell to tip of vein M_{1+2} (fig. 1, H) (Sumatra) ..... **mantissa** Hering

8. Hind margin of mesonotum broadly black and with two longitudinal black vittae extending over most of dorsum. Cell Sc dark brown and with a brown spot on vein M_{1+2} between crossveins (fig. 1, A) (Sumatra) ..... **appendiculata** Enderlein

Mesonotum rufous except for an abbreviated vitta on each side from inside humerus to just before suture. Wings rather evenly yellow fumose with a dark spot at the apex of cell R_5 and across m crossvein (fig. 1, C) (Sumatra) ..... **flavicans** (Edwards)

9. Crossvein r-m situated well beyond the middle of 1st M_2 10

Crossvein r-m situated at basal third of 1st M_2 (fig. 1, B) (New Guinea) ..... **flava** (Edwards)

10. Abdomen with at least two spots on the fifth tergum. Wings at least slightly yellowish fumose 12

Abdomen entirely yellow. Wings hyaline (fig. 1, D) (Bismarck Archipelago) ..... **holoxantha** Hering

11. Wings chiefly yellow fumose, intensely so at base and on anterior portion. Cell Sc all yellow. Posterior portion of wing broadly gray-brown fumose (fig. 2, A). Female with two spots on sixth tergum. Ovipositor base equal to the combined lengths of segments 4 and 5 (Solomon Islands) ..... **quadripunctata** Malloch

Wings subhyaline, slightly yellowish. Posterior portion of wing nearly hyaline. Apex of cell Sc brown. Sixth tergum of female entirely yellow. Ovipositor base equal to segment 5 plus visible portion of 6. (Celebes) ..... **signata** (Walker)

Sophira appendiculata Enderlein (fig. 1, A)

Sophira appendiculata Enderlein, 1911, ZOOL. JAHRB. SYST. 31:434, fig. M.

This species fits near *S. flavicans* (Edwards) in my key but the two are obviously not closely related. *S. appendiculata* differs by having the wings predominantly pale yellowish with a brown mark only on vein M_{1+2} between the r-m and m crossveins and in cell Sc; by having a distinct lobe developed at lower apex of cell M_4 (fig. 1, A); and by having two black longitudinal vittae extending over most of the dorsum, and the hind margin of the mesonotum chiefly black.

The original description is adequate. Enderlein says that the scutellum has four long black bristles; I assume that it also has a pair of small secondary bristles.

Type locality: Soekaranda, Sumatra.

Type in the Stettiner Zoologischen Museum.

The species is apparently known only from the type male.

Sophira flava (Edwards) (fig. 1, B)

Rioxa flava Edwards, 1915, TRANS. ZOOL. SOC. LOND. 20(13):421, pl. XXXVIII, figs. 10, 10a.

This species is related to *S. quadripunctata* Malloch and to *S. signata* (Walker) but is readily differentiated by having the r-m crossvein situated near the basal third of cell 1st M_2 rather than well beyond the middle; also, as pointed out by Malloch (ANN. MAG. NAT. HIST. Ser. 11, Vol. 4:257, 1939), the markings of the body and wings are quite different.

An entirely yellow to rufous species except for the pair of black spots on the fifth abdominal tergum. Edwards' figure (10) is somewhat misleading, for it shows four dark vittae extending down the mesonotum; his type shows very faint evidence of what might be interpreted as vittae but these are not distinct. I believe these are entirely due to slight discoloration of the mesonotum; other specimens on hand from New Guinea show no indication whatsoever of any mesonotal vittae. Edwards also failed to show the black marks on the fifth tergum, and his r-m crossvein is near the basal two-thirds of cell 1st M_2. The bristles of the head and thorax are entirely yellow. The secondary scutellars are strong, they are two-thirds to three-fourths as long as the other bristles. The wing is as in figure 1, B. The third costal section, cell Sc, is about one-third longer than the second and is brown in the apical portion. A narrow band of brown extends from just before apex of vein R_{2+3} around the wing apex to just slightly beyond the tip of vein M_{1+2}. The m crossvein is clouded with brown, vein M_{3+4} is also gray-brown fumose. The basal third of the wing and the anterior margin are slightly yellow fumose. The apical portion is largely subhyaline and the posterior margin is grayish fumose. The r-m crossvein is situated near the basal third of cell 1st M_2. The spots on the sides of the fifth tergum are oblong in shape and extend slightly over one-half the length of the segment. The ovipositor is entirely yellow; the basal segment is approximately equal in length to segments 4 plus 5. The apex of the piercer appears to be rather blunt and has two strong setae, one on each side just behind apex.

Type locality: Mimika River, Netherlands New Guinea.

Type in the British Museum (Natural History).

I have examined the type female, which is in poor condition; it apparently is discolored, the abdomen is missing, and one wing is broken. Three female specimens are in the collection from Kokoda, Papua. These have been reported by Malloch (PROC. LINN. SOC. N. S. WALES 64(3–4):430, fig. E, 1939—he saw four females). Malloch also stated that the type locality was "Utakwa River, Dutch New Guinea," but this is not the locality name which was on the type. I have one female specimen at hand from Laloki, Papua, 1919 (F. Muir). Hering (TREUBIA 21(3):521, 1953) recorded a female from Bernhard Camp, Netherlands New Guinea.

Sophira flavicans (Edwards) (fig. 1, C), new combination

Rioxa flavicans Edwards, 1919, JOUR. FED. MALAY STATES MUS. 8(3):50, fig. 26.

This species fits in my key near *appendiculata* Enderlein but the two are not related. As shown in the key, the description below, and in figure 1, C, the wing and body markings are very different in the two species.)

A predominantly yellow to rufous species, with a short black vitta extending down the front portion of the thorax on each side from behind the humerus to just before the suture. Occiput with a dark brown to black spot on each upper corner, just behind upper level of eyes. Only part of the scutellars and the supraalar bristles remain on the thorax and head of the type, and these are black. The fourth abdominal tergum has a small black spot on each side. The fifth has an oval-shaped black spot on each side extending approximately one-half the length of the segment. The sixth tergum is entirely rufous. Female ovipositor yellow, the basal segment, *in situ*, is just slightly longer than abdominal segments 5 plus 6. Wings rather intensely yellow fumose. The third section of the costa is approximately equal to or just slightly longer than the second. Cell Sc is entirely yellow. A faint brownish discoloration (rather quadrate in shape) is situated near the apex of vein R_{2+3}, extending from costa to about the middle of cell R_3. The apical portion of cell R_5 has a brown to brownish black spot and a streak of brown to black fumosity extending over the m crossvein; a faint indication of this also extends up into cell R_5 just above the m crossvein, and a faint brownish streak extends along the underside of vein M_{3+4} for about half its length. The r-m crossvein is situated near the apical third of cell 1st M_2. Edwards' wing photograph (which is reproduced here, fig. 1, C) is not very good, and the contrast between the yellow and brown markings is not clearly shown.

Type locality: Sungei Kumbang, Korinchi, Sumatra.

Type in the British Museum (Natural History).

The species is known only from the type. Edwards indicated in his description that the type was a male. I have examined it and it is a female. The type is in fair condition except that the antennae and many of the bristles have been broken off.

Sophira holoxantha Hering (fig. 1, D)

Sophira holoxantha Hering, 1941, SIRUNA SEVA 3:21, fig. 19.

This species is very close to *Sophira signata* (Walker) and apparently differs by having the abdomen entirely yellow, lacking black spots on the fifth tergum; by having the basal segment of the ovipositor about equal in length to abdominal segments 4 plus 5, rather than equal to segments 5 plus the visible portion of 6; by having the wings hyaline, not slightly yellowish; and by having the narrow costal band originating before the apex of cell Sc, and

cell Sc almost entirely hyaline (fig. 1, D), rather than having the costal band beginning just beyond the tip of vein R_1, and the apex of cell Sc brown.

An all-yellow species except for a black spot on each side of the face. The bristles are all yellow. Wings as in figure 1, D.

Type locality: Ralum, Bismarck Archipelago.

Type in the Zoologisches Museum, Humboldt Universität, Berlin.

Known only from the type female. I have studied this specimen.

Sophira insueta Hering (fig. 1, E)

Sophira insueta Hering, 1952, TREUBIA 21(2):274, fig. 6.

This is related to *S. limbata borneensis* Hering but is differentiated by having the apex of cell R_3 largely brown fumose and the second costal cell brown (fig. 1, E).

Head yellow except for a black transverse mark behind the vertex which extends into the black spot on the ocellar triangle. Thorax brownish yellow, with two widely separated black vittae on the mesonotum extending from the mesonotum to the suture, and also with a brown spot on each side between the presutural and notopleural bristles and another black mark on each side in the supraalar area. The mesopleura lack a dark vertical band. The abdomen is chiefly yellow with the first tergum brownish, the second black on the anterior half, the third and fourth with a black band across the base, and the fifth and sixth with a black spot on each side. The ovipositor is one-half longer than segments 5 plus 6. Legs yellow. Wings pale yellow with a dark brown to black band extending from near base of second costal cell to apex of vein R_{2+3} and with another broad brown band extending from apices of cells R_5 and 2nd M_2 over vein M_{1+2}, obliquely over the m crossvein, and through upper half of cell M_4 to the apex of cell Cu (fig. 1, E).

Type locality: West Java.

Type in the Rijksmuseum van Naturlijke Historie, Leiden.

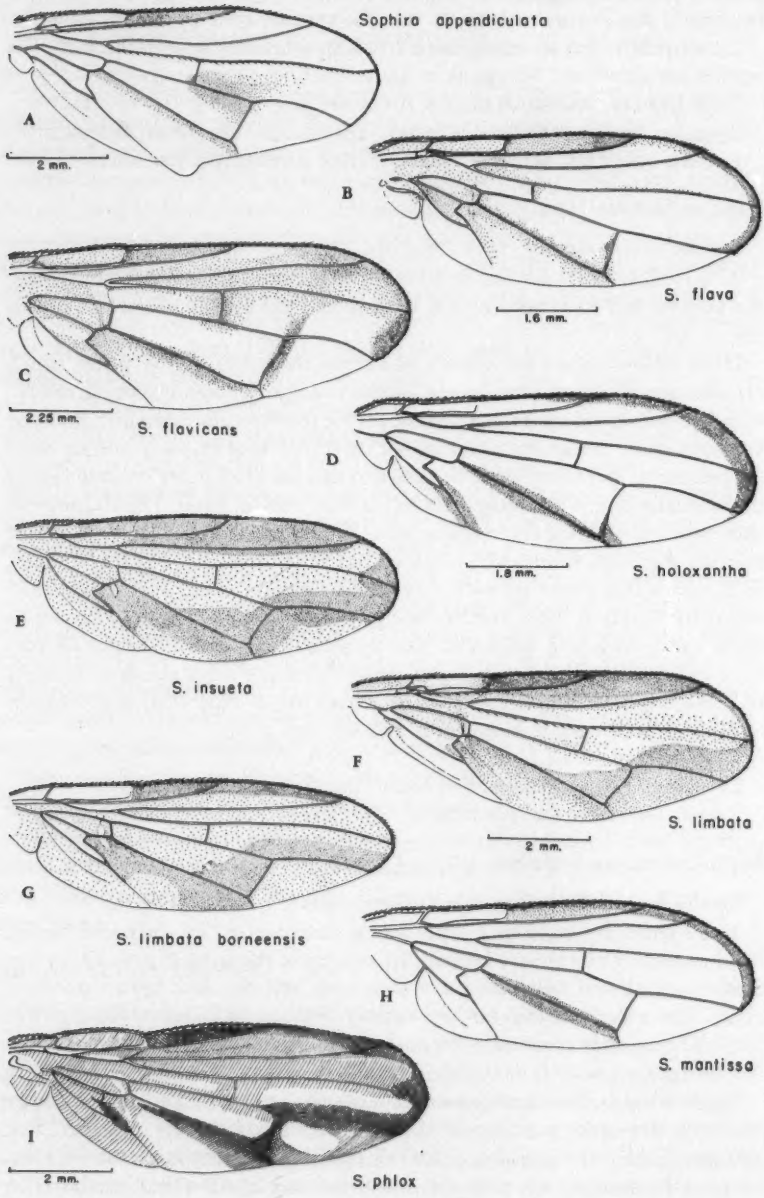
Known only from the type female.

Sophira limbata Enderlein (fig. 1, F)

Sophira limbata Enderlein, 1911, ZOOL. JAHRB. SYST. 31:435, fig. N.

This species fits close to *S. phlox* and is characterized by the broad brown band extending all the way around the margin of the wing (fig. 1, F), by the black markings on the thorax and abdomen, and the dark brown to black tibiae. The wing markings are somewhat like those of *S. insueta* Hering (fig. 1, E). That species apparently differs by lacking the black vertical band over the mesopleura, as well as in other details.

The head of *limbata* is rufous with a black band extending across the vertex and onto the upper portions of the occiput, behind the eye margins. The bristles of the head and thorax are all black. The secondary scutellars are comparatively small, not over one-fourth as long as the other bristles. The


Sophira appendiculata
A
2 mm.
B
S. flava
1.6 mm.
C
2.25 mm.
S. flavicans
D
1.8 mm.
S. holoxantha
E
S. insueta
F
S. limbata
2 mm.
G
S. limbata borneensis
H
S. mantissa
I
2 mm.
S. phlox

thorax is predominantly yellow in ground color with two shining black vittae extending from outer scapular bristles to about opposite the anterior supraalar bristles. The hind portion of the mesonotum is polished black. A shining, black, vertical stripe extends across the pleura from each sternopleuron over the mesopleuron, onto the dorsum through the area between the humerus and notopleuron in front of the suture, almost connecting with the submedian black vittae. The metapleura, hypopleura, and the metanotum are shining black. The scutellum is all yellow. The legs are yellow to rufous except for the brown to black tibiae. The wings are as in figure 1, F. The third costal section is slightly longer than the second, and the r-m crossvein is situated at about the apical three-fifths of cell 1st M_2. The brown band through the posterior portion of the wing is narrowly connected with that of the anterior margin by a thin band extending around the margin in cell R_3. The first abdominal tergum is rufous. The second has a black band across the middle and is otherwise yellow. The third and fourth terga are largely yellow, and each has an arcuate black band extending across the basal portion and curving down on the sides to posterior lateral corners of the segment. Fifth tergum with a black spot on each side. Ovipostor rufous, the basal segment, *in situ*, slightly longer than segments 5 plus 6. Segment 6 also has a black spot on each side.

Malloch (PROC. LINN. SOC. N. S. WALES 64(3–4):431, 1939) recorded the only known male specimen of *limbata*. He said the male has a prominent conical protuberance on each gena which is armed with numerous curled black hairs at the apex, that the legs are entirely yellow, and that "there is some difference also in the bristling of the legs."

Type locality: Sumatra.

Type in the Stettiner Zoologischen Museum.

Described from two females. I have studied eight female specimens in the British Museum collection from Mt. Bulit, junction of Rivers Tinjar and Lejok, Sarawak, Borneo, 13-9-32, Oxford Univ. Exped. (B. M. Hobby and A. W. Moore). This record was reported by Perkins (ANN. MAG. NAT. HIST., Ser. 11, Vol. 2:402, 1938—he reported 11 females). Malloch (*loc. cit.*) also recorded it from Borneo.

Sophira limbata borneensis Hering (fig. 1, G)

Sophira limbata borneensis Hering, 1952, TREUBIA 21(2):273, fig. 5.

This subspecies differs from typical *limbata* by the wing markings. The brown costal band is not continuous around the wing margin but is broken

FIG 1. A, *Sophira appendiculata* Enderlein, copied from original. B, *S. flava* (Edwards), specimen from Laloki, Papua. C, *S. flavicans* (Edwards), copied from original. D, *S. holoxantha* Hering, copied from original. E, *S. insueta* Hering, copied from original. F, *S. limbata* Enderlein, specimen from Sarawak, Borneo. G, *S. limbata borneensis* Hering, copied from original. H, *S. mantissa* Hering, copied from original. I, *S. phlox* Munro, copied from original.

through cell R_3, the upper part of cell R_5, and through cell 2nd M_2. The apical portion of cell 2nd M_2 is pale brownish to dark smoky fumose—not as pale colored as would seem to be indicated by Hering's figure 5 (fig. 1, G). The other areas of the wing which are sparsely dotted on Hering's figure, except the hind margin, are clear yellow.

Type locality: East Borneo.

Type in the Rijksmuseum van Natuurlijke Historie, Leiden.

Known only from Borneo, and only females have been recorded. I have studied three paratypes in the Naturhistorisches Museum, Basel.

Sophira mantissa Hering (fig. 1, H)

Sophira mantissa Hering, 1952, TREUBIA 21(2):275, fig. 7.

This species fits in the key near *S. appendiculata* Enderlein and *flavicans* (Edwards), but the markings on the wings are very distinctive. The presence of a narrow brown costal band and a brown band over vein M_{3+4}, together with the presence of dark brown markings on the mesonotum, will distinguish it from other *Sophira*.

Head and appendages chiefly yellow. Face with a pair of large black spots. The third antennal segment is brown. Thorax reddish yellow with a pair of longitudinal vittae in the middle of the mesonotum and a dark spot behind each wing base. The metanotum has two black spots. Abdomen rufous with a black spot on each side of terga four and five. The basal segment of the ovipostor is slightly longer than abdominal segments 5 plus 6. Wings yellowish hyaline, the venation and markings as in figure 1, H. All of the body bristles are yellow-brown.

Type locality: East Sumatra.

Type in the Rijksmuseum van Naturlijke Historie, Leiden.

Known only from the type female.

Sophira phlox Munro (fig. 1, I)

Sophira phlox Munro, 1935, REC. INDIAN MUS. 37(1):25, fig. 6.

This species is related to *S. limbata* Enderlein, but, as pointed out in the key, the body and wing markings and coloration are quite different (fig. 1, I). In addition to these characters the lack of black bands on the abdominal segments will also differentiate *phlox* from *limbata*.

For a description of the species refer to the original.

Type locality: Garo Hills, Assam.

Type in the Indian Museum, Calcutta.

Known only from the type female.

Sophira quadripunctata Malloch (fig. 2, A)

Sophira quadripunctata Malloch, 1939, ANN. MAG. NAT. HIST. Ser. 11, Vol. 4:255, pl. XI, fig. 17.

This species is related to *S. signata* (Walker) and is differentiated by the wing markings, by the presence of two black spots on the sixth tergum, and by the longer basal segment of the ovipositor, as pointed out in the key.

A predominantly rufous to orange-yellow species with brownish red bristles. The thorax is entirely rufous and the abdomen is red except for a large black spot on each side of segment 5; these extend approximately four-fifths the length of the segment. The sixth tergum has a small black spot on each side. The ovipositor is rufous, and the basal portion, *in situ*, is approximately equal in length to abdominal segments 4, 5, and 6 together. The wings are predominantly yellow fumose basally and along anterior portion, with a distinct brown costal band extending around the wing apex to the tip of vein M_{1+2}. The hind portion of the wing is rather deeply gray-brown fumose. The third section of the costa is about one-fourth to one-third longer than the second. The r-m crossvein is situated near the apical third of cell 1st M_2 (fig. 2, A). The species has been adequately described by Malloch. His wing photograph, which I have reproduced here, is not too good.

Type locality: Lunga, Guadalcanal, Solomon Islands.

Type in the British Museum (Natural History).

Known only from the type female. I have studied this specimen. It is in poor condition, as the head and one wing are missing.

Sophira signata (Walker), new combination

Seraca signata Walker, 1860, JOUR. PROC. LINN. SOC. LONDON 4:165.

This species is related to *S. quadripunctata* Malloch and differs by having the wings subhyaline, slightly yellowish, with the posterior portion nearly hyaline, and the apical portion of cell Sc brown fumose. *S. quadripunctata* has wings predominantly yellow, intensely so at the basal and anterior portions, with the posterior portion broadly gray-brown fumose, and the subcostal cell yellow. *S. signata* also differs by having the sixth tergum of the female entirely yellow, rather than with two black spots. *S. signata* is somewhat more slender in build, and the ovipositor base is shorter than in *quadripunctata*. The base is equal to abdominal segment 5 plus the visible portion of 6, rather than being equal to segments 4 plus 5. It is also related to *S. holoxantha* Hering but differs by having black spots on the fifth tergum, rather than having the abdomen entirely yellow.

An entirely pale yellow species except for the black spots on the fifth tergum. The costal and basal cells of the wings are almost hyaline. The r-m crossvein is situated at the apical two-thirds to three-fourths of cell 1st M_2. The narrow brown costal band is continuous from just beyond the tip of vein R_1 to the apex of vein M_{1+2}. The species has not been figured in the literature.

Type locality: Makassar, Celebes.

Type in the British Museum (Natural History).

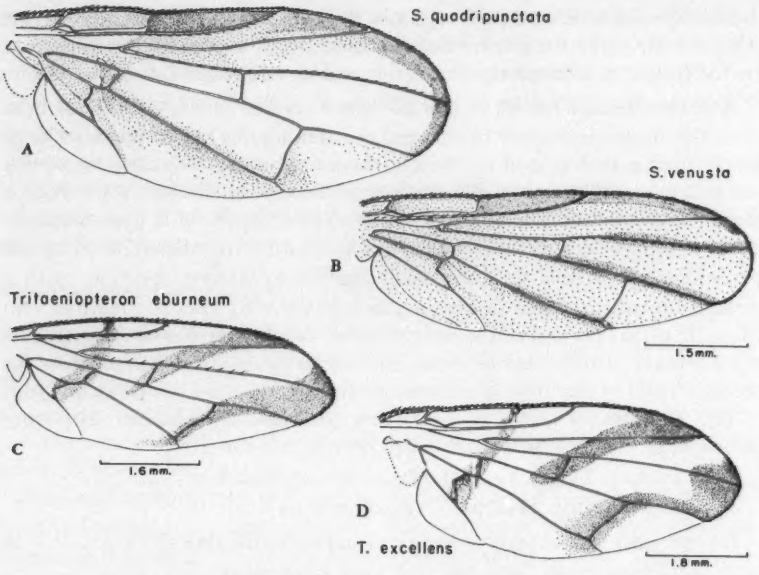


FIG. 2. A, *Sophira quadripunctata* Malloch, copied from original. B, *S. venusta* Walker, type specimen. C, *Tritaeniopteron eburneum* de Meijere, copied from original. D, *T. excellens* Hendel, copied from original.

Known only from the type female. I have examined this specimen. It is in fair condition except that the wings are damaged, and I was unable to make a drawing of the venation and maculation.

Sophira venusta Walker (fig. 2, B)

Sophira venusta Walker, 1857, JOUR. PROC. LINN. SOC. LOND. 1:35.

This species is characterized from all other known *Sophira* by the marking on the wings: having a longitudinal brown streak along each of veins R_{4+5}, M_{1+2}, and M_{3+4}, in addition to a brown costal band (fig. 2, B).

A predominantly yellow species. The pleura each have a vertical stripe of black extending from the lower part of the sternopleuron to the upper margin of the mesopleuron; this extends onto the mesonotum at the suture. The mesonotum also has a narrow black vitta on each side in line with the outer scapular bristles, extending as far as the anterior supraalar bristles. The hind portion of the mesonotum is black. The first abdominal tergum is yellow. The second has a black transverse band near its base. The third and fourth terga each have a moon-shaped black band extending across the basal margin in the middle and curving posteriorly toward the posterior lateral margins of the segment. The fifth tergum has an oblique black stripe on each side, ex-

tending from the posterolateral margin to the base of the segment. The wings are predominantly yellow fumose; the markings are as in figure 2, B.

Type locality: Singapore.

Type in the British Museum (Natural History).

I have examined the type female and one other female specimen from Molucca (British Museum collection). Enderlein (1911, ZOOL. JAHRB. 31:434) recorded three female specimens from Sumatra, and Hering (1952, TRUEBIA 21(2):273) recorded a female from Borneo.

Genus **Tritaeniopteron** de Meijere

Tritaeniopteron de Meijere, 1914, TIJDS. V. ENT. 57:209.

Pale-colored flies looking very much like *Sophira* Walker. This has previously been treated as a synonym under *Sophira*. (See Hendel, ANN. MUS. NAT. HUNG. 13:441, 1915, and Shiraki, MEM. FAC. SCI. AGR. TAIHOKU IMP. UNIV. 8:320, 1933.) I am convinced that *Tritaeniopteron* is a good genus differing from *Sophira* by the short subcostal cell, scarcely over half as long as the second costal cell; by the presence of strong sternopleural bristles; and by the presence of transverse bands on the wings (fig. 2, C).

Type of the genus: *Tritaeniopteron eburneum* de Meijere

KEY TO KNOWN SPECIES OF TRITAENIOPTERON

Face entirely yellow. Abdominal terga three to five with black spot on each side (Formosa) ..... **excellens** (Hendel)

Face with a black spot in lower median portion. Abdominal terga three to five each with a black band along the base (Java) ..... **eburneum** de Meijere

Tritaeniopteron eburneum de Meijere (fig. 2, C)

Tritaeniopteron eburneum de Meijere, 1914, TIJDS. V. ENT. 57:209, pl. 6, fig. 14.

This species is obviously very close to *T. excellens* (Hendel). I see no significant differences in the wing venation and maculation and comparatively slight differences in body markings in comparing with Hendel's original description and with the supplemental description published by Shiraki (MEM. FAC. SCI. AGR. TAIHOKU IMP. UNIV. 8:322, 1933). *T. eburneum* apparently differs by having a black spot on the lower median portion of the face; by having a black band across the bases of abdominal terga three to five; and by having the basal segment of the ovipositor about equal to segments 4 plus 5.

Face and front all yellow, except for the black spot on lower median portion of face. Thorax predominantly pale yellow with a black spot behind each humerus which connects with a vertical black stripe which extends over the

mesopleuron and the sternopleuron. An almost complete circle of black is present on the hind half of the mesonotum, and the arms of this mark extend longitudinally to just behind the suture and are curved inward at this point toward the middle line. Legs entirely yellow. All bristles yellow. Abdomen and ovipositor as described above. Wing (fig. 2, C) subhyaline, yellowish on the basal portion; with three brown transverse bands, one at level of the tip of Sc, one oblique band from apex of cell R_1 across r-m crossvein, and another oblique band from apex of cell R_5 and lower apex of R_3 extending across the m crossvein.

Type locality: Tandjong Priok, Java.

Type in the Zoological Museum, Amsterdam.

I have examined the type and five cotypes. The above notes are based upon these specimens.

Tritaeniopteron excellens (Hendel), new combination (fig. 2, D)

Sophira excellens Hendel, 1915, ANN. MUS. NAT. HUNG. 13:441, pl. IX, fig. 14.

Sophira excellens Hendel, Shiraki, 1933, MEM. FAC. SCI. AGR. TAIHOKU IMP. UNIV. 8:322.

This species is very close to *T. eburneum* de Meijere and apparently is differentiated by having the face all yellow, lacking a black spot in the middle; by having a pair of black spots on each of abdominal terga three to five, rather than a black basal band on each segment; by having the mesonotum quite differently marked, as described below; and by having the basal segment of the ovipositor half as long as the abdomen, rather than equal to segments 4 plus 5.

Thorax shining, predominantly pale yellow to rufous. Mesonotum with a round black spot on each side before the suture and with a black streak on each side behind the suture.

Refer to Hendel and to Shiraki for more complete details, and to figure 2, D.

Type locality: Kankau, Formosa.

The type was in the Hungarian National Museum, Budapest.

Known from both sexes. Shiraki recorded it from Koshun, Formosa.

Extrafloral Glandular Secretions, a Food Source for Certain Insects[1]

TOSHIYUKI NISHIDA

HAWAII AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF HAWAII
HONOLULU, HAWAII

(*Presented at the meeting of December 9, 1957*)

The importance of food as a component of the environment is well recognized; however, the food habits of many insects, particularly those of the free-flying forms, are inadequately known. One of the little known habits is that of the feeding of insects on secretions produced by extrafloral glands. This aspect of insect biology was studied by the author during the course of investigations on the ecology and control of the melon fly, *Dacus cucurbitae* Coquillett. These investigations showed that extrafloral secretions, also referred to as nectar, were important food sources for this fly and that the application of insecticides to non-host plants including those with extrafloral glands resulted in a marked reduction in abundance of the melon fly in localized areas (Nishida and Bess, 1951, 1957; Nishida, 1954). In addition, these investigations as well as those conducted subsequently showed that, besides the melon fly, there were other insects which fed on extrafloral secretions. This paper presents a summary of the observations on these nectarivorous insects.

In addition to field observations, one of the important phases in a study of this type is the identification of the species under observation. For the assistance that he received in identification, the author is indebted to Dr. D. Elmo Hardy and Miss Marian Adachi, Hawaii Agricultural Experiment Station, University of Hawaii; Mr. Fred Bianchi, Experiment Station, Hawaiian Sugar Planters' Association; and Mr. Kiyoshi Ito, Pineapple Research Institute of Hawaii.

EXTRAFLORAL GLANDS AND SECRETIONS

Specialized secretory glands, known to produce sugar-like secretions called nectar, are present within the flower and on other organs of plants (Eames and McDaniels, 1947). This paper is concerned only with those glands located outside of the flower and which are thus referred to as extrafloral glands. These glands, although well known to botanists, have not been studied to any great extent from an entomological standpoint.

[1] Published with the approval of the Director of the Hawaii Agricultural Experiment Station as Technical Paper No. 410.

Extrafloral glands vary in shape, size, and appearance. In general they are circular and range from 1 to 4 mm. in diameter. The glands on some plants are raised wart-like structures, while those on other plants are not raised at all but can be readily detected by the pale white or greenish color and the smooth glossy texture of the secretory surface. In addition, there are glands which are funnel shaped. Some of the glands are small and inconspicuous, but they produce sizable clear droplets of liquid which are particularly noticeable during the early morning hours. Some of the typical glands are shown in figure 1.

The common weeds and cultivated plants on which extrafloral glands are present and the organs on which they are located are given in table 1. The glands on cattleya orchids, *Cattleya* spp., are located on the peduncle, one on the base of each of the three calyces. On the cotton plant, *Gossypium barbadense* L., the glands are present on the peduncle and on each of the three main veins of the palmately veined leaf. Those on the peduncle are large and are clearly visible at the bases of the calyces; however, those on the veins are small and may be seen with difficulty. The small funnel-shaped glands on wild euphorbia, *Euphorbia geniculata* Ortega, occur singly on the calyx. Although small, these glands are readily seen because they protrude outward from the upper lateral side of the well developed calyx (fig. 1, D). The glands on the yellow passion fruit, *Passiflora edulis* f. *flavicarpa* Degener, are located on the petiole and calyx. On the petiole they occur in pairs on the extreme distal end at the point of attachment of the lamina (fig. 1, A). The glands on the calyces are small, but may be readily seen on the flower buds (fig. 1, C). The glands on peach, *Prunus persica* L., are usually found in pairs at the distal end of the petiole. Extrafloral glands are most numerous on castor bean, *Ricinus communis* L., where they are present along the petiole (fig. 1, B), stem, and axis of the inflorescence. There are also numerous glands along the entire length of the seed pod of ground orchids, *Spathoglottis* spp. These glands are inconspicuous, but they can be readily located when the clear droplets of nectar are present.

The nutritive value of extrafloral glandular secretions to insects has not been studied to any great extent. However, on the basis of available information in the literature it is evident that certain nutrients are present in such secretions. Clark and Lukefahr (1956) found by use of chromatographic methods that the extrafloral secretions of the cotton plant contained a number of sugars including sucrose, glucose, fructose, ribose, rhamnose, and raffinose. These workers reported that no amino acid was detected in the extrafloral secretions of the cotton plant. A further study on the effect of feeding simulated cotton nectar, a mixture of the known sugars found in the secretion of the cotton plant, on the fecundity and longevity of the pink bollworm moth, *Pectinophora gossypiella* (Saunders), was conducted by Lukefahr (1956). This study showed that there were no significant differences in fecundity among groups of moths fed on (1) simulated nectar, (2) honey and

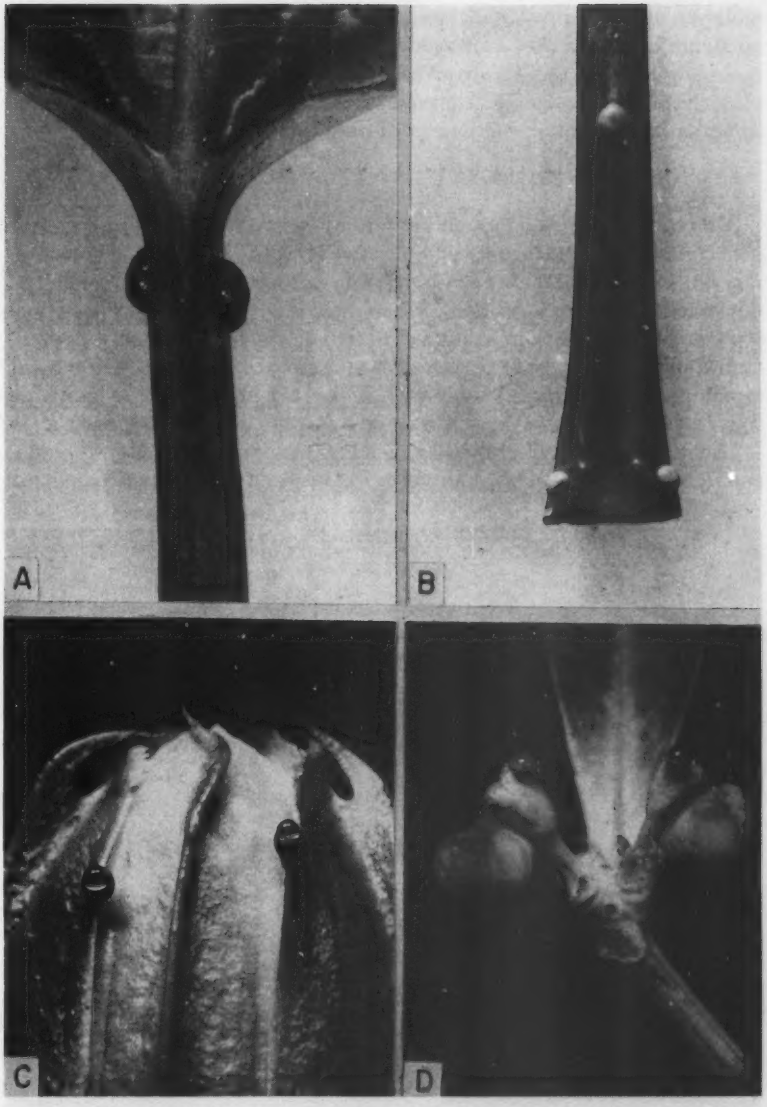


FIG. 1. Extrafloral glands of some common plants. A, a pair of glands on the petiole of the yellow passion fruit, *Passiflora edulis* f. *flavicarpa* Degener; B, glands on the basal region of the petiole of castor bean, *Ricinus communis* L.; C, glands on the flower bud of the yellow passion fruit; and D, glands on wild euphorbia, *Euphorbia geniculata* Ortega. Note clear droplets of secretions in figures A, C, and D.

molasses, and (3) honey, molasses and protein hydrolysate. There were also no significant differences in longevity among moths fed on these diets. Although studies on the nutritive value of secretions produced by Hawaiian plants have not been conducted, these results suggest that extrafloral glandular secretions do contain substances of nutritional value to insects.

Insects Observed to Feed on Extrafloral Secretions

Although there is variation in the feeding behavior of different species, a general idea as to the manner in which insects feed on extrafloral secretions may be obtained from figure 2, which shows a group of melon flies feeding on the secretions of the castor bean. When there is a copious flow of secretions the insects usually remain in their characteristic feeding position for several minutes. However, when the secretions are scarce they may be seen moving rapidly from one gland to another. It is also not unusual to see individual wasps and flies "pecking" at each other presumably to gain access to the glands.

The insects that were observed to feed on extrafloral glandular secretions and the plants on whose secretions they fed are listed in table 2. Although not

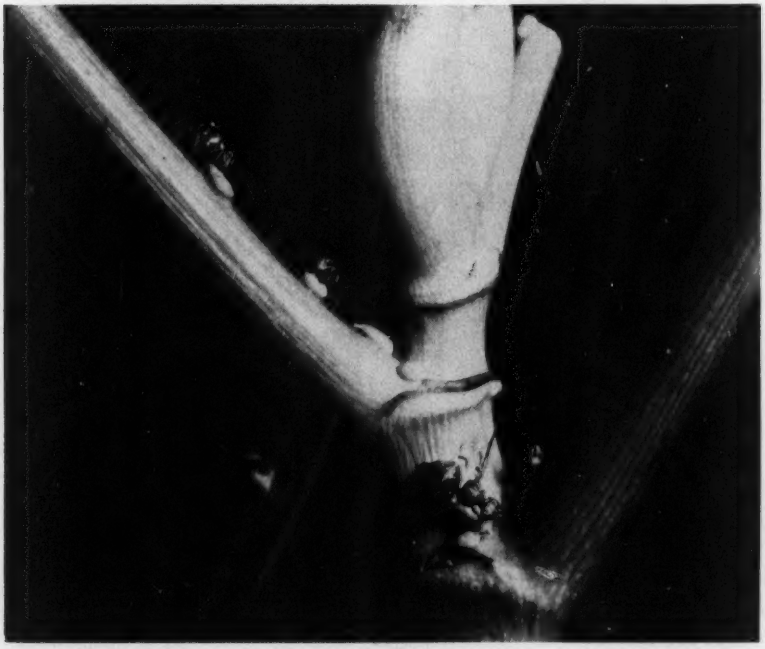


Fig. 2. Melon flies, *Dacus cucurbitae* Coquillett, feeding on glands of castor bean, *Ricinus communis* L.

TABLE 1. List of some common plants bearing extrafloral glands and the location of the glands.

PLANT	Stem	Petiole	Vein	Peduncle	Calyx	Seed Pod	Axis of Inflorescence
Cattleya spp.				x			
Gossypium barbadense L.			x	x			
Euphorbia geniculata Ortega					x		
Passiflora edulis f. *flavicarpa* Degener		x			x		
Prunus persica (L.)		x					
Ricinus communis L.	x	x					x
Spathoglottis spp.						x	

listing an impressive array of insects, this table shows that there are a number of species that feed on such secretions, an indication of the importance of extrafloral secretions as a food source for the insects concerned. Included in the list are 26 species, all in the adult stage, in the orders Orthoptera, Coleoptera, Hymenoptera, and Diptera.

Very few species in the Orthoptera and Coleoptera were observed to feed on extrafloral secretions. The only species in the Orthoptera was a grasshopper, *Conocephalus saltator* (Saussure), an omnivorous insect known to feed on soft-bodied insects as well as on plants, and in the Coleoptera, a coccinellid, *Coelophora inaequalis* (Fabricius). Neither of these insects was observed to feed on glandular secretions very frequently, but at times considerable numbers were found feeding on the secretions of the castor bean. It appears that they feed on glandular secretions only in times of food scarcity.

The largest number of species found feeding on glandular secretions belonged to the Hymenoptera. In this order ants were the most abundant and they were most consistently associated with such glanduliferous plants as castor bean and passion fruit. Probably because of the aggressive foraging habits of ants, other insects were rarely seen feeding on the secretions of plants visited by large numbers of ants. The remaining species in the Hymenoptera were, with the exception of the honey bee, *Apis mellifera* L., either parasitic or predaceous. In general the food habits of the immature stages of these insects are known, but those of the adult stages are inadequately known. To what extent the adults depend upon extrafloral glandular secretions as a food source is not known.

In the Diptera only a few species were observed to feed on extrafloral secretions. The melon fly, *Dacus cucurbitae* Coquillett, and the oriental fruit fly, *Dacus dorsalis* Hendel, two species of economic importance, were most frequently observed to be associated with such plants as castor bean, wild euphorbia, and the cultivated passion fruit. It was indeed a surprise not to find the Mediterranean fruit fly, *Ceratitis capitata* Wiedemann, feeding on

TABLE 2. Adult insects observed feeding on extrafloral glandular secretions and the plants on whose secretions the respective insects were observed to feed.

INSECTS	*Caitleya* spp.	*Euphorbia geniculata*	*Gossypium barbadense*	*Passiflora edulis*	*Prunus persica*	*Ricinus communis*	*Spathoglottis* spp.
Orthoptera							
Tettigoniidae							
Conocephalus saltator (Saussure)						x	
Coleoptera							
Coccinellidae							
Coelophora inaequalis (Fabricius)						x	
Hymenoptera							
Formicidae							
Cardiocondyla nuda Mayr	x			x		x	x
Iridomyrmex humilis Mayr		x		x		x	
Monomorium minutum Mayr	x			x	x	x	x
Pheidole megacephala (Fabricius)	x			x	x	x	x
Plagiolepis mactavishi Wheeler						x	x
Solenopsis geminata rufa			x			x	
Apidae							
Apis mellifera L.		x		x		x	
Megachilidae							
Megachile schauinslandi Alfken		x					
Crabronidae							
Nesocrabro sp						x	
Ampulicidae							
Ampulex compressa (Fabricius)						x	
Vespidae							
Polistes exclamans exclamans Viereck		x	x			x	
P. fuscatus var. *aurifer* (Saussure)		x		x		x	
P. macaensis (Fabricius)		x		x		x	
P. olivaceus DeGeer		x		x		x	
Evaniidae							
Evania appendigaster L.						x	
Ichneumonidae							
Enicospilus hawaiiensis (Ashmead)						x	
Idechthis canescens (Gravenhorst)						x	
Braconidae							
Opius oophilus Fullaway						x	
Apanteles trifasciatus Muesebeck						x	
Diptera							
Syrphidae							
Eristalis arvorum (Fabricius)		x		x		x	
Tephritidae							
Dacus cucurbitae Coquillett		x		x		x	
Dacus dorsalis Hendel		x		x		x	
Muscidae							
Musca domestica L.						x	
Calliphoridae							
Phoenicia sericata (Meigen)						x	

extrafloral secretions. Observations made in the areas of Kula, Maui, and Kona, Hawaii, where this fly occurs, showed that not a single fly was present on castor bean even though this plant was fairly common.

In addition to the insects listed in table 2, other insects, particularly small Diptera and Hymenoptera, were also observed on plants with extrafloral glands. It is probable that these insects also feed on glandular secretions; however, because they were not actually observed to feed, they were not included in the list.

Discussion

The observations reported in this paper show that there are a number of insects that feed on extrafloral glandular secretions. The question immediately arises as to whether the insects imbibe this liquid to obtain water or nutrients. This question cannot be answered on the basis of the present study, for although these secretions have been shown to have nutritive value (Lukefahr 1956) they also contain a high percentage of water. However, regardless of whether the insects obtain water or nutrients, or both, it seems quite evident that these secretions play an important role in the biology of the insects concerned.

It appears from the data presented in table 2 that some insects fed on the secretions of a few plants, while others fed on the secretions of a number of plants; thus one is tempted to conclude that there is a specificity on the part of the insects concerned to secretions produced by certain plants. However, such a conclusion is not warranted because the information presented was obtained from a few isolated plants in many cases and from widely scattered areas under diverse ecological situations.

On the basis of the observations reported in this paper it is possible to present a partial explanation for the close insect-plant relationships frequently encountered in the field. It is not uncommon, for example, to see numbers of non-phytophagous insects or the non-phytophagous adult stage of otherwise phytophagous insects closely associated with certain plants. Although the reason for this behavior is not entirely clear at the present time, it appears that the attractiveness to insects of extrafloral glandular secretions is one of the contributing factors to such an association.

Summary

This paper is concerned with observations on extrafloral secretions as a food source for certain insects in Hawaii. Among some of the common plants, extrafloral glands were found to be present on Cattleya orchids, *Cattleya* spp.; cotton, *Gossypium barbadense* L.; wild euphorbia, *Euphorbia geniculata* Ortega; yellow passion fruit, *Passiflora edulis* f. *flavicarpa* Degener; peach, *Prunus persica* L.; castor bean, *Ricinus communis* L.; and ground orchids, *Spathoglottis*

spp. The extrafloral secretions produced by these plants were fed upon by the adults of 26 species of insects; one each in the Orthoptera and Coleoptera, 19 in the Hymenoptera, and 5 in the Diptera.

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Harry Scott Smith

1883–1957

Professor Harry Scott Smith, "Prof Harry" to his many close friends, died suddenly on Thanksgiving Day, November 28, 1957, at the age of 74. Known internationally as a teacher, scholar, an administrator, and a pioneer thinker in the field of population dynamics and biological control, he left behind a landmark in the history of entomolgy.

Prof Harry was born on November 29, 1883, at Aurora, Nebraska. He received an A.B. degree from The University of Nebraska in 1907 and a Master's degree a year later. From 1908 to 1912 he was employed as an expert in the Bureau of Entomology, United States Department of Agriculture. During this brief period he was closely associated with L. O. Howard, W. F. Fiske, W. R. Thompson, C. H. T. Townsend, F. Silvestri, J. D. Tothill, and P. H. Timberlake, all of whom were or later became distinguished in the field of the biological control of insect pests. In 1913 Prof Harry became associated with biological control work in California. In 1923 he became a member of the staff of the Citrus Experiment Station at Riverside and was in charge of biological control activities until his retirement in 1951. Under his leadership a large staff was assembled and both he and the Division of Biological

Control became world famous for their leadership in biological control. Riverside became the major center for biological control work in the United States and their facilities and research findings have been generously shared with many students and visiting colleagues from various countries throughout the world. Within the Division a laboratory of insect pathology was established and subsequently the first formal course in insect pathology was given at the University of California.

Many honors have been bestowed upon Prof Harry, who was an honorary member of the Hawaiian Entomological Society. He served both as vice-president and president of the American Association of Economic Entomologists and on a number of important entomological committees sponsored by the Pacific Science Congress, National Research Council, and Navy Department. He was repeatedly invited to participate on insect population and biological control panels sponsored by national and international organizations. Following his retirement the University of Nebraska bestowed an Honorary Doctor of Science degree upon him in recognition of his scholarly and effective research in his chosen profession.

Few men have had as many close professional and personal friends as Prof Harry. Colleagues in other scientific areas constantly sought his advice in designing definitive experiments and in the interpretation of their data. His students and colleagues recognized his keen perception in the solution of problems and the ability to state in simplified form the seemingly complicated hypotheses and theories of other scientists.

Prof Harry is survived by his wife and five children. His devotion to his family and numerous friends was sensed by all who came to know him during his long entomological career. In his characteristically unassuming and generous attitude he was always willing to give freely of his time and himself to help his students and colleagues and then gave them credit for his contributions to biological control and population studies. —Henry A. Bess

Orchamoplatus, An Australasian Genus (Homoptera: Aleyrodidae)

LOUISE M. RUSSELL

ENTOMOLOGY RESEARCH DIVISION, AGRICULTURAL RESEARCH SERVICE, U.S.D.A.
WASHINGTON, D. C.

(*Presented at the meeting of December 9, 1957*)

Orchamoplatus is here proposed as a new name for *Orchamus* Quaintance and Baker (1917, pp. 381, 400) because the latter is preoccupied by *Orchamus* Stål (1876, p. 30) in the Orthoptera. This paper defines the genus and the species assignable to it. One species originally included in *Orchamus* Quaintance and Baker is synonymized, one is placed elsewhere, eight are redescribed, and two are described as new, bringing to ten the number of species now recognized in the genus.

The known distribution of *Orchamoplatus* ranges from Japan to New Zealand and from Australia to the Society Islands, and thus includes portions of three of the major zoogeographical regions of the world. Members of the group are recorded from plants of five genera belonging to five families, and the hosts of two species are undetermined. Only two species are known from more than one genus of plants. The host associations of four species are of special interest because each inhabits citrus and one is particularly injurious to this food plant, while another is destructive to citrus and to croton, a plant of ornamental value. Five species are known to be parasitized.

In material examined the individual species exhibit relatively little variation in their structures and are amply distinct from one another. The study is based on the pupae, though other available stages were examined and characters of value noted. Unfortunately, few auxiliary stages were obtainable.

The terminology used here is the same as I have used in earlier papers (1943, 1947, 1948), but additional terms are applied to structures absent from insects that I have described previously.

The magnifications for the different drawings are uniform for all species and are approximately as follows: Outline, or dorsal half of body, × 86; tracheal pore area, vasiform orifice, setae, and spines, each × 283. The minute submarginal setae and the invaginated pores are not shown in the illustrations of the dorsal half of the body but are depicted in illustrations of the tracheal pore areas if present in the section drawn.

The illustrations were prepared by Arthur D. Cushman, Entomology Research Division, United States Department of Agriculture.

I am greatly indebted to the following persons for the loan of specimens

examined in this study: J. W. Beardsley, Jr., Hawaiian Sugar Planters Association, Honolulu, Hawaii; J. P. Doncaster, British Museum (Natural History), London, England; and L. J. Dumbleton, Christchurch, New Zealand. I am also grateful to Mr. Doncaster for bringing to my attention the fact that *Orchamus* Quaintance and Baker is preoccupied.

Orchamoplatus, new name for **Orchamus** Quaintance and Baker

Aleuroplatus (*Orchamus*) Quaintance and Baker, 1917, U. S. NAT. MUS. PROC. 51:381, 400; Sampson, 1943, ENT. AMER. (n.s.) 23:208. (Type species, *Aleuroplatus* (*Orchamus*) *mammaeferus* Quaintance and Baker, by original designation).

Orchamus Quaintance and Baker, Dumbleton, 1956, ROY. ENT. SOC. LONDON PROC. (ser. B) 25 (pts. 7–8):131–132, 141.

Type species of *Orchamoplatus: Aleuroplatus* (*Orchamus*) *mammaeferus* Quaintance and Baker.

Quaintance and Baker established *Orchamus* as a subgenus on the basis of the dentation of the inner surface of the vasiform orifice in *mammaeferus*. Dumbleton elevated the subgenus to generic rank and mentioned the presence of a linear series of submarginal papillae.

Because of variation in the dentation of the vasiform orifice, this feature does not characterize the genus, nor does it separate *Orchamoplatus* from *Aleuroplatus*; but the two are readily distinguishable on the basis of other characters.

Orchamoplatus has a row of submarginal glands[1]; it has a pair of submedian setae on the first abdominal segment; in it the tracheal pore area teeth are dissimilar to the marginal teeth; and the tracheal pore areas usually are sharply demarked from the adjacent derm. *Aleuroplatus* does not possess any of these structures that characterize *Orchamoplatus* and separate it from all other genera.

Generic Description.—Living on the lower surface of leaves.

Secretion colorless or yellowish, transparent or translucent, glassy, present on the dorsal and ventral surface and around the body.

Body colorless or yellowish and membranous, or brown or black and sclerotized. Ovoid or oval, or subelliptical to subcircular; nearly flat.

Margin and submargin: Margin smooth, crenulate, or dentate. Anterior and posterior setae arising from edge of margin or tips of teeth. Tracheal pore areas with teeth strongly differentiated from rest of margin, demarked from adjacent derm. Ridges evident near margin. Glands present; each one a subcylindrical extension of body wall with outer end dentate; an internal

[1] These structures have been called papillae, pores, and tubercles by other writers; but since they are dissimilar to the structures that I have previously described under these names, I use "gland" in order to distinguish them from the other organs. They are secretory in function, wax emanating from them much as from other types of pores.

funnel-shaped duct extending inward from outer end and narrowing to a threadlike tube near inner end of gland. Minute setae distad of glands; three pairs on cephalic, two on mesothoracic, and one on each of abdominal segments 4 and 5. Invaginated pores distad of, and much less numerous than glands; minute and often barely distinguishable, somewhat resembling porettes but smaller and not associated with disk pores.

Dorsal disk: A pair of submedian setae on abdominal segment 1, on segment 8 near vasiform orifice, and a caudal pair. Disk pores and porettes, and invaginated pores present. Transverse molting suture anterior to thoracoabdominal one. Intersegmental sutures rather obscure except in median and submedian area of abdomen, but the posterior two abdominal ones curved laterocaudad into subdorsum. Eight segments apparent in median area of abdomen; segment 7 at least one-half the length of segment 6. Submedian depressions present. Submedian pockets well defined. Vasiform orifice subcircular or subcordate, rising above adjacent derm. Operculum subcircular or subcordate. Lingula spatulate.

Ventral surface: Marginal wax tubes very weak. Tracheal folds usually broad, shallow, and weak. Thoracic spiracles thimble-shaped, area around opening lightly sclerotized; anterior and posterior abdominal spiracles present, smaller than thoracic ones. Antenna reaching anterior thoracic spiracle, one-segmented, the end abruptly narrowed and bearing numerous minute spines and two very small sensory setae. Beak apparently two-segmented, apparently two pairs of minute setae at tip. Legs stout, outer side strongly curved, segmentation indistinct; each leg with three minute setae on inner basal area, one at anterior and posterior ends and one near midlength of middle and posterior legs, one at anterior and two near midlength of anterior leg; each leg with a minute slender seta near disk, and with a minute stout seta and two clear areas resembling setal bases at disk. A pair of submedian adhesive sacs on mesothorax. Ventral abdominal setae located at least their length from posterior spiracles. Male organ a bifid sac.

Third-stage larva: Margin dentate; tracheal pore area teeth differentiated from others. Marginal, submarginal, and dorsal setae as in pupae.

Key to Species of Orchamoplatus

1. Each thoracic tracheal pore area expanded into a conspicuous plate that extends into the subdorsum, and teeth recessed in submargin with a narrow slit to margin 2

   Each thoracic tracheal pore area not expanded into a plate, and teeth not recessed in submargin or if so with a wider opening to margin . . 3

2. Abdominal tracheal pore area expanded into a crescent-shaped plate that extends laterocephalad each side of the vasiform orifice; thoracic tracheal pore area plates large, with ends in line with sec-

ond or third gland each side of pore area; each tracheal pore area with two teeth; caudal setae anterior to penultimate pair of glands; dorsum membranous throughout.... **porosus** (Dumbleton), p. 406

Abdominal tracheal pore area not expanded; thoracic tracheal pore area plates smaller, with ends in line with first gland each side of pore area; each tracheal pore area with four to six teeth; caudal setae mesad of posterior pair of glands; dorsum sclerotized in median area.... **noumeae,** new species, p. 405

3. Ventral surface with numerous spines 2-25 μ long arranged in a definite pattern distad of legs, antennae, and mouthparts; glands in a single row and with four to six additional pairs mesad of row on abdominal segments 1 to 4.... **citri** (Takahashi), p. 397

Ventral surface without or with few spines and these not more than 5 μ long and not arranged as above; glands in a single row, without additional ones.... 4

4. Dorsum entirely membranous and colorless or pale yellow.... 5

Dorsum partially or entirely sclerotized and partially or entirely dark brown or black.... 6

5. Cephalic setae absent; tracheal pore area teeth slender; caudal setae at lateral margin of abdominal tracheal pore area and three times the width of a posterior gland apart.... **mammaeferus** (Quaintance and Baker), p. 393

Cephalic setae present; tracheal pore area teeth less slender, finger-like; caudal setae at cephalic margin of abdominal tracheal pore area and the width of a posterior gland apart.... **montanus** (Dumbleton), p. 398

6. Margin smooth or weakly crenulate.... 7

Margin strongly dentate.... 9

7. Dorsum colorless and membranous except for a brown, sclerotized area that extends from the cephalic segment to the posterior abdominal one in median and submedian area; cephalic setae absent.... **incognitus** (Dumbleton), p. 399

Dorsum entirely dark brown or black and sclerotized; cephalic setae present.... 8

8. Tracheal pore area teeth about 20 μ long, slender, narrowly rounded apically, eight to thirteen in number; eye spots present; vasiform orifice 32–40 μ long and wide, its opening subcircular and well defined; margin crenulate.... **caledonicus** (Dumbleton), p. 400

Tracheal pore area teeth 12 μ long, stout, broadly rounded apically, six to nine in number; eye spots absent; vasiform orifice 96 μ long and 112 wide, its opening narrow, transverse, obscure; margin smooth.... **plumensis** (Dumbleton), p. 408

9. Marginal teeth rounded; thoracic tracheal pore area teeth recessed within margin; about 40 glands on each half of body.....
.....**dentatus** (Dumbleton), p. 403
Marginal teeth acute; thoracic tracheal pore area teeth not recessed within margin; 57 to 66 glands on each half of body.....
.....**calophylli,** new species, p. 402

Orchamoplatus mammaeferus (Quaintance and Baker), new combination (fig. 1, A–D)

Aleuroplatus (*Orchamus*) *mammaeferus* Quaintance and Baker, 1917, U. S. NAT. MUS. PROC. 51:400–401, illus.; Drews and Sampson, 1940, BROOKLYN ENT. SOC. BUL. 35:92.

Aleuroplatus mammaeferus Quaintance and Baker, Dozier, 1928, JOURN. AGR. RES. 36(12):1002; Corbett, 1935, FED. MALAY STATES MUS. JOURN. 17:781–782, illus.; Takahashi, 1940, NAT. HIST. SOC. FORMOSA TRANS. 30(205):382.

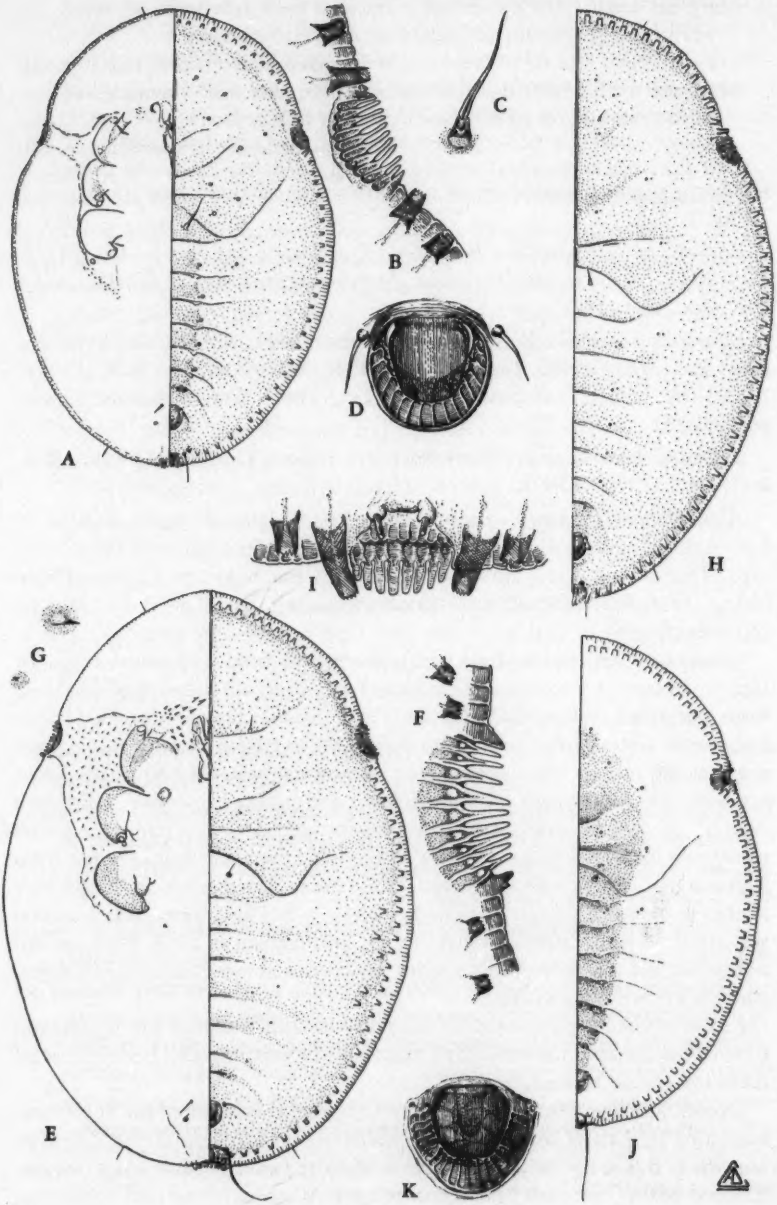
Orchamus mammaeferus (Quaintance and Baker), Dumbleton, 1956, ROY. ENT. SOC. LONDON PROC. (ser. B) 25(pts. 7–8):131.

Aleuroplatus (*Orchamus*) *samoanus* Laing, 1927, INSECTS OF SAMOA, pt. 2, fasc. 1:43–45, illus.; Dozier, 1928, JOURN. AGR. RES. 36(205):1002–1005, illus.; Dumbleton, 1953, HAWAIIAN ENT. SOC. PROC. 15:21–22, illus.; Dumbleton, 1956, ROY. ENT. SOC. LONDON PROC. (ser. B) 25(pts. 7–8):131–132. (New synonymy.)

Quaintance and Baker described *mammaeferus* from *Codiaeum variegatum* Blume, Botanical Gardens, Buitenzorg, Java; and Laing described *samoanus* from cultivated croton, Apia, Upolu Island, Samoa. Dozier identified specimens from *Citrus medica* Linn. from Tahiti, Society Islands, as *samoanus*, stating that the species was closely allied to *mammaeferus*. Corbett implied that *samoanus* was a synonym of *mammaeferus*, and pointed out that "cultivated croton" in Malaya does not belong to the genus *Croton* but is *Codiaeum variegatum* Blume. Dumbleton (1953) recorded *samoanus* from orange from Rarotonga, Cook Islands, and later (1956) stated that this species might be a synonym of *mammaeferus*. Dumbleton (1954, p. 87) also stated that *samoanus* was reported from citrus in Guam by G. D. Peterson in 1953. Peterson did not record the presence of this species, however, and no member of *Orchamoplatus* is known from Guam.

I have studied type material of *mammaeferus* and *samoanus* and representatives of the material identified by Dozier and Dumbleton and believe that all these insects are *mammaeferus*.

Dozier, and also Dumbleton (1953), indicated that some of the specimens examined by Dozier may have been collected on Hikueru in the Tuamotu Islands. If this is the case, *mammaeferus* and the genus *Orchamoplatus* are distributed farther eastward than recorded here. Washburn's second expedition


A
B
C
D
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to the South Pacific took place in 1925 rather than in 1926, as stated by Dozier and Dumbleton.

Laing, Dozier, and Dumbleton mentioned the enormous numbers of *mammaeferous* on the leaves, and Dumbleton stated that this species was one of the main pests of orange in Rarotonga. The abundance of the insects may be striking indeed, they and their secretions virtually covering the lower surface of the leaves. I have not observed a parasitized insect in the hundreds of specimens examined.

Secretion colorless or yellowish, transparent, that from one insect often coalesced with wax from others, extending outward nearly as far as greatest width of body.

Colorless or yellowish, membranous. Oval, slightly indented at thoracic tracheal pore areas, widest across metathorax; 0.75–1 mm. long and 0.50–0.70 mm. wide (males in lower brackets of figures).

Margin and submargin: Marginal crenulations weak except for 1 to 4 (usually 1 or 2) each side of tracheal pore areas that are produced into strong teeth; 15 to 18 in 100 μ. Anterior marginal setae about 10 μ long, posterior marginal about 25 μ. Tracheal pore area teeth 6 to 14 (usually 7 to 11) in number, slender, narrowly rounded apically, swollen and sharply demarked from adjacent derm at base, the longest thoracic ones about 36–40 μ including base, and the longest abdominal ones about 20 μ. Ridges moderately defined from margin to glands. Glands in a single row terminating about the length of one laterocephalad of abdominal tracheal pore area; 40 to 47 in number with 12 to 17 anterior and 26 to 31 posterior to thoracic tracheal pore area on each half of body; 1 to 2 times the width of one apart and approximately the length of one from margin; the majority 10–12 μ long and 8–9 wide, but one 16–20 μ long each side of thoracic tracheal pore areas. Invaginated pores about one-fourth as numerous as glands, midway between margin and glands. Submarginal setae 4 μ long, slightly nearer to glands than to margin. A weak ridge curved similarly to anterior margin of body, proximad of glands, usually terminating at thoracic tracheal pore areas but sometimes extending onto abdomen.

Dorsal disk: Transverse molting suture with midpoint slightly posterior to meso-metathoracic suture, extending laterocaudad at a sharp angle nearly to first abdominal suture, then recurved and terminating slightly cephalad of ends of meso-metathoracic suture or continued laterocephalad into outer subdorsum. Median length of abdominal segment 7 about three-fourths that

FIG. 1. *Orchamoplatus mammaeferus:* A, dorsal and ventral halves of body; B, thoracic tracheal pore area and adjacent derm; C, first abdominal seta; D, vasiform orifice. *O. citri:* E, dorsal and ventral halves of body; F, thoracic tracheal pore area and adjacent derm; G, ventral spines. *O. montanus:* H, half of dorsum; I, abdominal tracheal pore area and adjacent derm. *O. incognitus:* J, half of dorsum; K, vasiform orifice.

of segment 6. Disk pores and porettes unusually large, submedian ones in 2 pairs on cephalic segment and in 1 pair on meso- and metathoracic and on abdominal segments 2 to 6; subdorsal disk pores and porettes in 1 pair on cephalic, meso- and metathoracic, and abdominal segments 2 or 3. A pair of subdorsal invaginated pores on cephalic, mesothoracic, metathoracic, and on abdominal segments 3 to 6 and 8. Setal bases elongate; length of setae including bases: first abdominal 60–70 μ; eighth abdominal 32 μ, close to and slightly anterior to widest part of vasiform orifice; caudal 80–100 μ, contiguous to laterocephalic edge of abdominal tracheal pore area, bases about twice the length of a gland apart. Vasiform orifice subcircular, 32–40 μ long and wide, approximately its length from posterior suture and from abdominal tracheal pore area; rising above adjacent derm and highest at posterior end, sclerotized; inner wall vertical, with narrow vertical ridges; bottom sometimes reticulated, extending cephalad about one-half the length of the orifice. Operculum subcircular, 24–28 μ long and wide. Lingula shorter than operculum.

Ventral surface: Minute spines sparse, located between antenna and mouthparts, slightly nearer to spiracle than to body margin in thoracic tracheal fold, laterad of anterior abdominal spiracle and extending mesocaudad to abdominal segment 3.

Third-stage larva: Marginal teeth as long as wide; 5 to 7 at each tracheal pore area slightly longer and more slender than others. Dorsal setae located as in pupae. Two pairs of submedian elongate tubular ducts on cephalic segment; a subdorsal pair on meso- and metathoracic and on abdominal segments 4, 5, 6, and 8. A pair of submedian disk pores and porettes on meso- and metathorax.

Redescribed from numerous unmounted and mounted specimens as given below. On *Codiaeum variegatum* Blume, Botanical Garden, Buitenzorg, Java, R. S. Woglum, January 1911, lectotype and syntypes of *mammaeferus*. On *Codiaeum* sp., Japan, intercepted at Philadelphia, Pa., A. B. Wells, Oct. 2, 1939. On croton as follows: Apia, Upolu, Samoa, P. A. Buxton and G. H. Hopkins, April 1925, lectotype and syntypes of *samoanus*; Apia, Samoa, L. J. Dumbleton, Oct. 30, 1953; Fiji, intercepted at New South Wales, W. W. Froggatt, one lot May 14, 1898, one lot with letter of May 6, 1919; Java, one lot, and two lots without locality, Harold Compere; Singapore, Straits Settlements, one lot S. I. Kuwana, May 8, 1924, one lot C. P. Clausen, 1929, one lot intercepted at New Orleans, La., J. C. Pritchett, Aug. 26, 1935; Federated Malay States, intercepted at New Orleans, La., K. E. Miller, July 18, 1935; Japan, intercepted at Baltimore, Md., L. M. Scott, Oct. 29, 1934; Nelson, New Zealand, from W. J. Hall, letter Jan. 6, 1954; Australia, intercepted at Honolulu, Hawaii, J. P. Young, Apr. 10, 1955. On *Citrus medica* Linn., Tahiti, Society Islands, F. L. Washburn, August 1925, reported as *samoanus* by Dozier. On citrus, Rarotonga, Cook Islands, L. J. Dumbleton, July 1949. On unnamed host, one lot from Japan, intercepted at Philadelphia, Pa.,

J. H. Ramos, July 3, 1935; one lot from Suva, Fiji, R. A. Lever, Sept. 16, 1940, from E. C. Zimmerman.

It is likely that at least some of the hosts listed as croton are *Codiaeum variegatum*, since this plant is commonly known as croton in many of the areas from which *mammaeferus* is reported.

Mammaeferus, *dentatus*, and *incognitus* are alike in lacking cephalic setae and in having unusually large disk pores, but they are amply distinct and may readily be recognized by differences in color, in the vasiform orifice, and in other characteristics. The third-stage larvae differ from those of *caledonicus*, *citri*, and *noumeae* in lacking cephalic setae, and from the last two in having eight pairs of elongate tubular ducts.

Orchamoplatus citri (Takahashi), new combination (fig. 1, E–G)

Aleuroplatus citri Takahashi, 1940, NAT. HIST. SOC. FORMOSA TRANS. 30(205):381–382, illus.; Anonymous, 1952, VICTORIA DEPT. AGR. JOURN. 50(pt. 1):10–11, 14; Jenkins and Shedley, 1953, JOURN. AGRIC. WEST AUSTRALIA 2(ser. 3):49–55, illus.; Jenkins and Shedley, 1953, WEST. AUSTRAL. DEPT. AGRIC. LEAFLET 2027:3–[7], illus. (reprint of last article).

Orchamus citri (Takahashi), Dumbleton, 1956, ROY. ENT. SOC. LONDON PROC. (ser. B) 25(pts. 7–8):131–132.

Although the anonymous writer did not use the scientific name of the whitefly on citrus, the insect is believed to be *Orchamoplatus citri*; the report is from "Citrus Field Day at Mildura," and specimens of *citri* are at hand from this host and locality.

The anonymous writer, and Jenkins and Shedley discussed the injuriousness of this species, and the latter authors stated that a slight measure of control of the insects was being achieved by parasites.

In material examined, the insects are very abundant and numerous specimens are parasitized.

Differing from *mammaeferus* as described below.

Not yellowish. Ovoid, scarcely indented at thoracic tracheal pore areas, anterior end narrower than posterior, widest across abdominal segments 1 and 2.

Margin and submargin: None, or 1 to 3 marginal crenulations each side of tracheal pore areas produced into strong teeth. Tracheal pore area teeth 7 to 15 (usually 9 to 12) in number, bluntly pointed apically, less sharply demarked from adjacent derm at base, the longest thoracic ones about 30, and the longest abdominal about 24 μ; the thoracic ones in a space about 60, and abdominal ones in a space 48 μ wide. Glands in a single row and 4 to 6 additional ones mesad of row on abdominal segments 1 to 4 inclusive; 50 to 58 in number with 15 to 18 anterior and 34 to 43 posterior to thoracic tracheal pore area on each half of body; terminating laterad of abdominal tracheal pore area; the majority 10 μ long and 8 wide but posterior pair 8 μ long, those

beside thoracic tracheal pore areas same length as others; outer ones on abdominal segments 1 to 4 times the length of one from margin. Ridge absent proximad of glands.

Dorsal disk: Transverse molting suture terminating nearly opposite its midpoint, ends directed laterad. Disk pores and porettes very small, no submedian pair on abdominal segment 2. Invaginated pores obscure, observed only on abdominal segments 3, 4, and 5. Cephalic setae present, 20–25 μ long; first abdominal 60 μ; eighth abdominal 32–40 μ; caudal 160–200 μ, bases 4 to 5 times the length of a gland apart.

Ventral surface: Spines numerous on cephalothorax; a few outside posterior legs and extending cephalad along tracheal fold in a broad band to margin, continued cephalad around anterior legs and mouthparts to median line, also present between anterior legs and mouthparts; the majority about 2 μ long but many cephalic ones larger and as much as 25 μ long. A pair of minute submedian setae on abdominal segment 2.

Third-stage larva: Marginal teeth as long as wide, 7 to 10 at each tracheal pore area longer and more slender than others. Submarginal setae as in pupae except that cephalic pair is proximad of submargin, in subdorsum. Dorsal setae located as in pupa and with 1 additional pair on cephalic segment laterad of cephalic pair, and a subdorsal pair on prothoracic and on abdominal segments 4 and 5; set in elongate bases. Ventral surface with spines arranged as in pupa except that they extend caudad to abdominal segment 5.

Redescribed from numerous mounted and unmounted specimens on citrus from Australia as follows: Sydney, New South Wales, N. S. Noble, Jan. 17, 1937, data the same as that of type material except for date; Sydney, New South Wales, from A. L. Tonnoir, May 4, 1936; Maddington, Western Australia, F. E. Ryan, from C. F. H. Jenkins, Nov. 30, 1950; Mildura District, Burnley, Victoria, C. J. R. Johnston, letter Feb. 15, 1951. On orange, Warawee, New South Wales, H. Compere, Nov. 18, 1927.

This species is rather closely related to *mammaeferus*, but is easily separated from it and other species of *Orchamoplatus* by having more than a single row of glands on the dorsal surface, and by the presence of numerous spines of various sizes on the ventral surface. The third-stage larvae differ from those of *caledonicus*, *mammaeferus*, and *noumeae* in having numerous spines on the ventral surface.

Orchamoplatus montanus (Dumbleton), new combination (fig. 1, H–I)

Orchamus montanus Dumbleton, 1956, Roy. Ent. Soc. London Proc. (ser. B) 25(pts. 7–8):132, 136, 141, illus.

Mounted specimens differing from *mammaeferus* as described below.

Not yellowish. Subelliptical, not indented at thoracic tracheal pore areas, widest across abdominal segment 1; 1.05 mm. long and 0.75 wide.

Margin and submargin: Tracheal pore area teeth 8 in number, rather stout,

fingerlike, the longest 28 μ; abdominal ones in a space 40 μ wide. Glands terminating less than the width of one laterocephalad of abdominal tracheal pore area; 55 in number with 16 anterior and 39 posterior to thoracic tracheal pore area on each half of body; one-half to one times the width of one apart, the majority one-fourth to one-half the length of one from margin but posterior pair extending just beyond margin; the majority 14–16 μ long and 11–12 wide but one 24–28 μ long each side of tracheal pore areas. Invaginated pores in line with outer end of glands. Submarginal setae near outer end of glands. Ridge absent proximad of glands.

Dorsal disk: Transverse molting suture with midpoint as near to thoracoabdominal as to meso-metathoracic suture; broadly curved laterocaudad to first abdominal suture, recurved and terminating opposite its midpoint. Disk pores and porettes small. Invaginated pores apparently in 2 pairs on abdominal segments 4 and 6. Cephalic setae 24 μ long; first abdominal broken near base; eighth abdominal broken near base, located on side of vasiform orifice; caudal setae broken but at least 80 μ long, on cephalic margin of abdominal tracheal pore area, their bases the width of a gland apart. Vasiform orifice 40 μ long and wide, lower portion of rim sclerotized and forming a thick ridge above adjacent derm but the top thin and membranous; inside membranous and less distinctly ridged, slightly expanded at posterior end. Operculum 36 μ long and wide.

Ventral surface: Minute spines absent.

Redescribed from one mounted paratype on a plant belonging to the Cunoniaceae, Mt. des Sourcés, New Caledonia, L. J. Dumbleton, Dec. 7, 1954.

Resembling *mammaeferus* but differing from it most prominently in the closeness of the caudal setae, the size of the posterior pair of glands, the shape of the tracheal pore area teeth, and the modification of the vasiform orifice.

Orchamoplatus incognitus (Dumbleton), new combination (fig. 1, J–K)

Orchamus incognitus Dumbleton, 1956, ROY. ENT. SOC. LONDON PROC. (ser. B) 25(pts. 7–8):132, 136–138, 141, illus.

Differing from *mammaeferus* as described below.

Dorsal surface brown in median and submedian area from cephalic segment to posterior abdominal one, colorless elsewhere. Widest across abdominal segment 1; 0.75–0.85 mm. long and 0.55–0.65 wide.

Margin and submargin: Tracheal pore area teeth 7 to 10 in number. Glands 49 to 51 in number with 16 anterior and 33 to 36 posterior to thoracic tracheal pore area on each half of body; about the width of one apart and slightly more than the length of one from margin; the majority 14 μ long and 12 wide but one 20–24 μ long each side of thoracic tracheal pore areas. Ridge proximad of glands faint, terminating at thoracic tracheal pore areas.

Dorsal disk: Longitudinal molting suture absent from meso- and metathorax of available specimens. Transverse molting stuture with midpoint as

near to thoracoabdominal as to meso-metathoracic suture, broadly curved laterocaudad and broadly recurved laterocephalad. First abdominal setae broken at base; eighth abdominal setae broken, located the width of its base from opening of vasiform orifice; caudal setae 140 μ long. Vasiform orifice weakly sclerotized; expanded inside, walls curved outward, and this portion larger than opening; expanded portion 44–48 μ long and wide, opening 32 μ long and wide; bottom extending cephalad three-fourths the length of orifice. Operculum 32 μ long and wide.

Redescribed from two mounted paratypes on undetermined host, New Caledonia, F. Cohic, collector, from L. J. Dumbleton.

This species is similar to *mammaeferus* in lacking cephalic setae, in having unusually large disk pores, and in having minute spines on the ventral surface. It differs from *mammaeferus* in having the inside of the vasiform orifice expanded, in having the median portion of the transverse molting suture curved instead of angular, and in being brown in the central portion of the dorsum.

Orchamoplatus caledonicus (Dumbleton), new combination (fig. 2, A–B)

Aleuroplatus (*Orchanus*) (sic!) *samoanus* Laing, Williams, 1944, HAWAIIAN PLANTERS' RECORD 48(2):100, in part.

Orchamus caledonicus Dumbleton, 1956, ROY. ENT. SOC. LONDON PROC. (ser. B) 25(pts. 7–8):132–134, 141, illus.

The insects recorded by Williams belong to the species *caledonicus* (Dumbleton) and *noumeae* new species. The spelling *Orchanus* doubtless is a typographical error, since in specimens labeled by Williams the spelling is *Orchamus*.

In material examined the insects are fairly abundant, with the waxy secretion from one specimen often reaching that from others. The pupae frequently are parasitized.

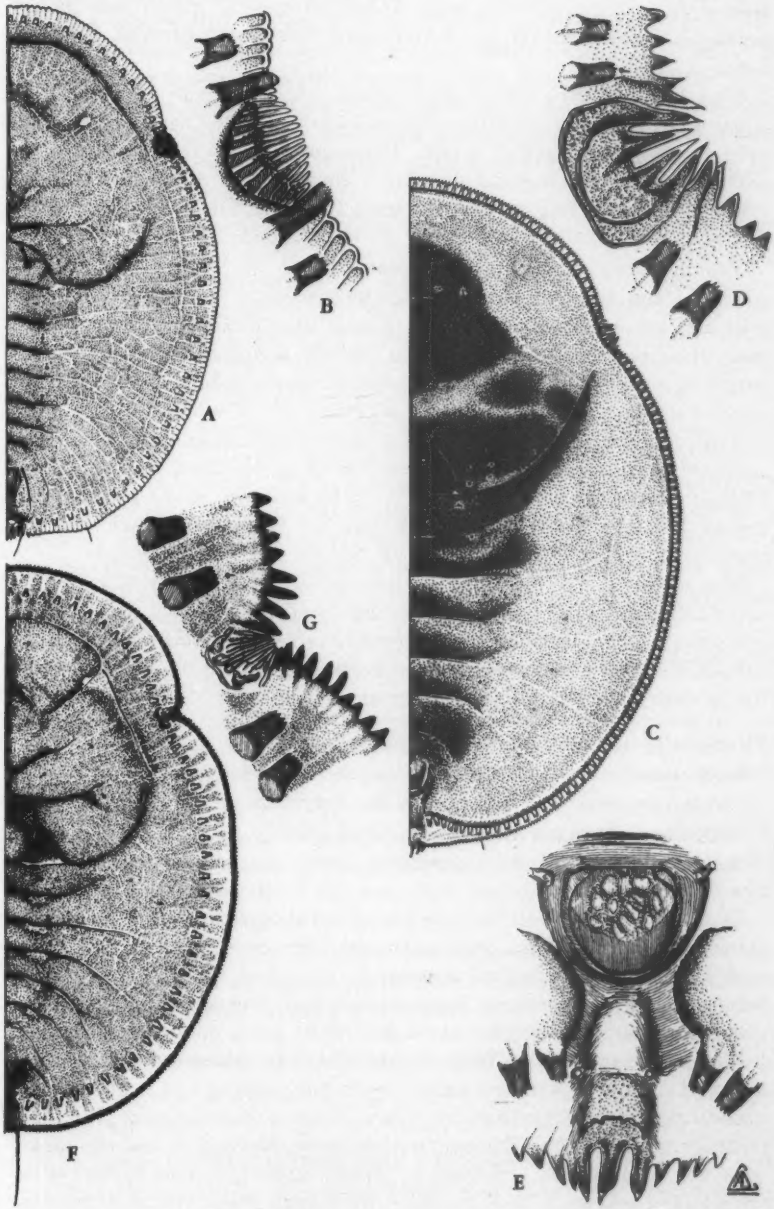
Differing from *mammaeferus* as described below.

Waxy secretion not yellowish.

Dorsal surface dark brown, sclerotized, lightly sculptured in subdorsum. Broadly ovoid, widest across abdominal segments 1 and 2; 0.70–0.90 mm. long and 0.50–0.75 wide.

Margin and submargin: Marginal crenulations slightly stronger, 13 to 15 in 100 μ. Tracheal pore area teeth 8 to 13 in number; the abdominal ones in a space about 40 μ wide, basal portion of abdominal pore area porous appearing and strongly demarked from adjacent derm. Ridges defined for one-third the distance from margin to glands. Glands 39 to 49 in number with 13 to 16 anterior and 25 to 33 posterior to thoracic tracheal pore area on each half of body; the majority 12–16 μ long and 10–12 wide but one 20–24 μ long each

FIG. 2. *Orchamoplatus caledonicus:* A, half of dorsum; B, thoracic tracheal pore area and adjacent derm. *O. calophylli:* C, half of dorsum; D, thoracic tracheal pore area and adjacent derm; E, part of posterior segment. *O. dentatus:* F, half of dorsum; G, thoracic tracheal pore area and adjacent derm.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side of thoracic tracheal pore areas. Ridge proximad of glands well defined on cephalothorax, weaker on abdomen and terminating between segments 3 and 7.

Dorsal surface: Eye spots light in color, oval, well removed from ridge. Transverse molting suture with midpoint slightly nearer to meso-metathoracic than to thoracoabdominal suture. Intersegmental sutures more distinct. Median length of abdominal segment 7 equal to that of segment 6. Disk pores and porettes smaller. Cephalic setae 25 μ long; first abdominal broken but at least 60 μ; eighth abdominal 60–68 μ; caudal 120 μ.

Ventral surface: Minute spines absent.

Third-stage larva: Marginal teeth longer than wide, 5 to 7 at each tracheal pore area more slender than others. Dorsal setae located as in pupa. Two pairs of submedian elongate ducts on cephalic segment, one at about mid-length of segment and one mesad of cephalic setae; a subdorsal pair on meso- and metathoracic and on abdominal segments 4, 5, 6, and 8.

Redescribed from approximately 100 unmounted and mounted specimens collected in New Caledonia as follows: On citrus, Noumea, F. X. Williams, Oct. 31, 1940; on citrus, Noumea, L. J. Dumbleton, 30/12 paratype; on orange, Noumea, F. Cohic, May 1953, from L. J. Dumbleton; on *Ochrosia* sp., intercepted at Washington, D. C., J. F. Schoen, Feb. 28, 1956.

This species can be distinguished from *mammaeferus*, to which it is rather closely related, by the brown color of the dorsal surface, by the presence of eye spots, and by the presence of cephalic setae. The third-stage larvae of *caledonicus* differ from those of *mammaeferus* in having the marginal teeth longer than wide, and in the presence of cephalic setae.

Orchamoplatus calophylli, new species (fig. 2, C–E)

In the small sample available the pupae are scattered, and only two are connected by their waxy secretion. A few specimens are parasitized.

Differing from *mammaeferus* as described below.

Secretion not yellowish, sometimes dull and translucent, very thick near body.

Dorsal surface black and heavily sclerotized except on submargin which is colorless and membranous. Subcircular, not indented at thoracic tracheal pore areas, widest across abdominal segment 2; 1–1.25 mm. long and 0.90–1 wide. Submargin strongly deflexed, upper portion nearly vertical; only the ends of glands and marginal teeth in view when insects are in normal position.

Margin and submargin: Teeth strong, triangular, apices acute, 12 to 13 in 100 μ; the majority 8–10 μ long and wide but none or 1 to 3 each side of tracheal pore areas larger than the others. Anterior marginal setae 12 μ long, posterior marginal 32 μ. Thoracic tracheal pore area teeth 6, and abdominal ones 3 to 6, in number, gradually or sharply tapered to acute apices, sometimes forked near tip, bases not swollen, the longest about 45μ; area proximad

of teeth porous appearing, ridged and strongly demarked from adjacent derm. Ridges well defined. Glands 57 to 66 in number with 16 to 20 anterior and 41 to 48 posterior to thoracic tracheal pore area on each half of body; the majority one-half to the width of one apart and about two-thirds the length of one from margin; 24–30 μ long and 10–12 wide; those adjacent to thoracic tracheal pore areas no larger than others. Ridge absent but a somewhat membranous line occupying its position proximad of glands, terminating near pro-mesothoracic suture.

Dorsal disk: Longitudinal molting suture terminating at membranous line. Transverse molting suture curved laterocaudad to first abdominal suture, broadly recurved and terminating at end of ridge near pro-mesothoracic suture; area encompassed within line and transverse molting suture easily broken from adjacent derm. Median length of abdominal segment 7 equal to that of segment 6. Disk pores and porettes small. Invaginated pores in 2 nearly contiguous pairs in each location. Setal bases not elongate; cephalic, first abdominal, and eighth abdominal setae broken at base; the last located the width of its base from opening of vasiform orifice, opposite anterior end of orifice; caudal setae 220 μ long, at cephalic end of abdominal tracheal pore area, bases about three-fourths the length of a gland apart. Vasiform orifice broadly cordate, about 60 μ long and 52 wide, area around posterior part of orifice slightly expanded; inside of orifice rather membranous and broadly ridged. Operculum about 45 μ long and 40 wide, its dorsal surface sclerotized and anterior half sculptured by 12 to 18 short longitudinal pits.

Ventral surface: Minute spines absent. A pair of minute submedian setae on abdominal segment 2.

Redescribed from about 15 unmounted and mounted specimens on *Calophyllum* sp., Neiafu, Vavau Island, Tonga, N. L. H. Krauss, February 1956, holotype and paratypes in the collection of the United States National Museum.

This interesting species is rather closely allied to *caledonicus* but differs from it in several ways, the most obvious being the acute marginal teeth, the smaller number and different shape and size of the tracheal pore area teeth, and the strongly deflexed submargin.

The densely black, heavily sclerotized pupae are difficult to mount satisfactorily, and most of those available are in unsatisfactory condition, being infested with fungus, parasitized, or broken.

Orchamoplatus dentatus (Dumbleton), new combination (fig. 2, F–G)

Orchamus dentatus Dumbleton, 1956, ROY. ENT. SOC. LONDON PROC. (ser. B) 25(pts. 7–8):132, 134–136, 141, illus.

Mounted specimens differing from *mammaeferus* as described below.

Dorsal surface black, sclerotized, lightly sculptured in subdorsum. Broadly

oval, deeply indented at thoracic tracheal pore areas, widest across abdominal segment 1; 0.85–0.95 mm. long and 0.70–0.80 wide.

Margin and submargin: Teeth strong, triangular, apices rounded, 17 to 18 in 100 μ; the majority 8 μ long and 6 wide but 1 to 4 each side of tracheal pore areas longer and more sharply pointed than others. Anterior marginal setae 20 μ long, posterior marginal 32 μ. Thoracic tracheal pore area teeth 8 to 9 in number, recessed within margin and adjacent marginal teeth nearly enclosing them; a small differentiated area proximad of teeth. Abdominal tracheal pore area teeth 6 to 8 in number, the longest about 32 μ; basal portion of area porous appearing and strongly demarked from adjacent derm. Ridges defined one-third the distance from margin to glands. Glands 38 to 39 in number with 12 to 13 anterior and 25 to 28 posterior to thoracic tracheal pore area on each half of body; the majority about twice the width of one apart and twice the length of one from margin; the majority 20 μ long and 10 wide but one 24–28 μ long each side of thoracic tracheal pore areas, inner end of gland sculptured on upper surface. Invaginated pores readily apparent. Ridge proximad of glands well defined on cephalothorax, terminating near meso-metathoracic suture.

Dorsal disk: Eye spots light in color, inner portion nearly circular but an irregular area extending outward to ridge. Longitudinal molting suture terminating at ridge. Transverse molting suture with midpoint just cephalad of thoracoabdominal one, extending laterocephalad at a broad angle, then abruptly caudad to first abdominal suture, broadly recurved and terminating at or near end of ridge. Intersegmental sutures well defined, extending into subdorsum. Disk pores and porettes smaller but unusually large, those on abdominal segments 5 and 6 largest. Invaginated pores readily apparent. First abdominal setae broken but at least 40 μ long; eighth abdominal 60 μ, located on swollen rim; caudal 160μ, bases the length of a gland apart. Vasiform orifice modified, its rim heavily sclerotized except at top, lower portion strongly expanded outward above adjacent derm and a shallow furrow around posterior portion, this area about 60 μ long and 80 wide and much larger than opening which is about 25 μ long and wide; inside expanded similarly to outside, ridges observed only near top, bottom extending cephalad nearly to anterior end of orifice; expanded area two-thirds its length from posterior suture and one-third its length from abdominal tracheal pore area. Operculum subcircular, 25 μ long and wide, sclerotized, its dorsal surface with minute spines at posterior end and with longitudinal striations anteriorly. Lingula not observed.

Ventral surface: Minute spines apparently absent.

Redescribed from two mounted paratypes on *Mooria artensis* Montr., Carenage, New Caledonia, L. J. Dumbleton, Apr. 8, 1955.

This species is rather closely related to *incognitus* but can be distinguished from it by the color of the dorsum, the presence of eye spots, the recessed

position of the thoracic tracheal pore areas, and the dentation of the body margin.

Orchamoplatus noumeae, new species (fig. 3, A–B)

Aleuroplatus (*Orchanus*) (sic!) *samoanus* Laing, Williams, 1944, HAWAIIAN PLANTERS' RECORD 48(2):100, in part.

The insects from New Caledonia listed as *samoanus* by Williams include both *caledonicus* (Dumbleton) and *noumeae*.

Representatives of *noumeae* are fairly abundant in the material examined. The pupae are infrequently parasitized.

Differing from *mammaeferus* as described below.

Secretion not yellowish, very thin, extending outward about one-half the greatest width of body; individual filaments sometimes apparent in fused mass.

Dorsal surface brown in median and submedian area from cephalic submargin to abdominal segment 4 or 5. Ovoid, widest across abdominal segments 1 and 2; 0.75–0.95 mm. long and 0.55–0.75 wide.

Margin and submargin: Marginal crenulations with 2 each side of thoracic tracheal pore areas, and 1 each side of abdominal tracheal pore area, produced into strong teeth. Thoracic tracheal pores recessed in submargin with a narrow slit leading to margin, a stout tooth on sides of pore, and 4 to 5 slender, tapering ones between them, with the longest about 20 μ; base of teeth not swollen; area proximad of teeth expanded into a pore plate that extends into subdorsum the depth of the pore, and cephalad and caudad in line with glands adjacent to pore; pore plate strongly demarked from adjacent derm. Abdominal tracheal pore area with 5 or 6 slender, fingerlike teeth, the longest about 20 μ, bases not swollen, a porous appearing area proximad of them. Glands terminating 1 to 2 times the length of one from abdominal tracheal pore area; 36 to 44 in number with 11 to 15 anterior and 24 to 30 posterior to thoracic tracheal pores on each half of body; about 3 times the width of one apart and one-half the length of one from margin; 8–10 μ long and 6–8 wide, ones near tracheal pore areas same size as others. Submarginal setae 2 μ long, in line with outer end of glands. Invaginated pores obscure, in line with ends of glands.

Dorsal disk: Transverse molting suture with midpoint slightly nearer mesometathoracic suture than thoracoabdominal one, extending laterocaudad at a broad angle. Disk pores and porettes small. Cephalic setae 50 μ long; first abdominal setae broken but at least 60 μ; eighth abdominal 32 μ, contiguous to vasiform orifice; caudal setae broken but at least 40 μ, bases about twice the width of a gland apart. Vasiform orifice 32–36 μ long and wide. Operculum 22–26 μ long and wide.

Ventral surface: Thoracic tracheal folds with minute spines from near legs nearly to margin, absent elsewhere.

Third-stage larva: Marginal teeth slightly longer than wide, tapered, apices rounded; 5 to 6 at each tracheal pore area more slender than others and not tapered. Dorsal setae located as in pupa and with 1 additional submedian pair on cephalic segment anterior to cephalic pair, and 1 subdorsal pair on meso- and metathoracic and on abdominal segments 4, 5, 6, and 8. A strong median tubercle on each of abdominal segments 2 to 6.

Described from about 50 unmounted and mounted specimens on citrus, Noumea, New Caledonia, F. X. Williams, Oct. 31, 1940; holotype and paratypes in the collection of the United States National Museum; paratypes in the collection of the Hawaiian Sugar Planters' Association.

This species is distinctive in having the combination of a recessed thoracic tracheal pore with an expanded pore plate, a median brown stripe on the dorsum, glands located near the margin, and numerous spines in the thoracic tracheal folds. The third-stage larva differs from those of *caledonicus*, *citri*, and *mammaeferus* in having median abdominal tubercles.

Orchamoplatus porosus (Dumbleton), new combination (fig. 3, C–D)

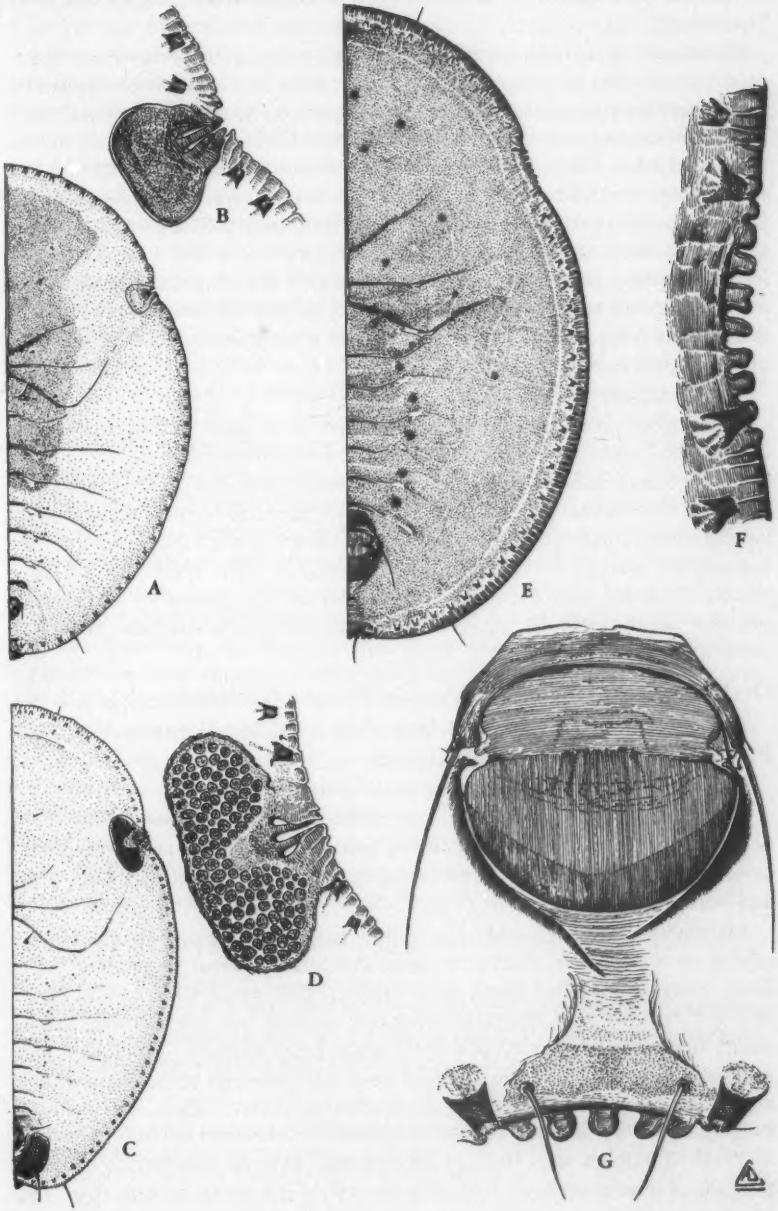
Orchamus porosus Dumbleton, 1956, ROY. ENT. SOC. LONDON PROC. (ser. B) 25 (pts. 7–8):132, 140–141, illus.

Mounted specimens differing from *mammaeferus* as described below.

Not yellowish. Widest across abdominal segment 1; 0.86 mm. long and 0.63 wide.

Margin and submargin: Marginal crenulations near tracheal pore areas not produced into strong teeth. Tracheal pores recessed in submargin; each one with sides produced into a short, stout tooth that extends just beyond adjacent marginal crenulations, and with 2 slender elongate teeth between them, the longest in any pore 16 μ; the thoracic pores with a narrow slit, but abdominal one with a wider opening leading to margin; each thoracic tracheal pore with a greatly expanded pore plate that extends into subdorsum and extends cephalad in line with the second, and caudad in line with the third gland from pore; abdominal pore with a crescent-shaped pore plate occupying the space between the pore and the vasiform orifice and extending cephalad beside orifice nearly to the eighth abdominal setae. Glands terminating about 3 times the length of one from abdominal tracheal pore; 49 to 50 in number with 15 anterior and 34 to 35 posterior to thoracic tracheal pore on each half of body; 2 to 3 times the width of one apart and the length of one from margin; 8–10 μ long and 6–8 wide, those each side of tracheal pore areas the same size as others. Submarginal setae 2 μ long, in line with outer end of glands. Invaginated pores in line with outer end of glands. Ridge proximad

FIG. 3. *Orchamoplatus noumeae:* A, half of dorsum; B, thoracic tracheal pore, pore plate, and adjacent derm. *O. porosus:* C, half of dorsum; D, thoracic tracheal pore, pore plate, and adjacent derm. *O. plumensis:* E, half of dorsum; F, thoracic tracheal pore area and adjacent derm; G, part of posterior segment.


A
B
C
D
E
F
G

of glands inconspicuous, terminating just cephalad of thoracic tracheal pore plates.

Dorsal disk: Transverse molting suture with midpoint slightly nearer meso-metathoracic than thoracoabdominal suture, terminating just laterocaudad of meso-metathoracic suture. Disk pores and porettes very small. Cephalic and first abdominal setae broken at base; eighth abdominal setae broken but at least 20 μ long, located twice the width of its base from vasiform orifice; caudal setae broken but at least 24 μ long, located cephalad of penultimate pair of glands, adjacent to pore plate. Vasiform orifice 60 μ long and wide, about two-thirds its length from posterior suture and one-third its length from abdominal tracheal pore; a narrow furrow between it and tracheal pore plate; inner wall rather membranous and not ridged. Operculum subcordate, about 44 μ long and 48 wide. Lingula 40 μ long and extending beyond operculum in available specimen.

Ventral surface: Minute spines absent.

Redescribed from one mounted paratype on a plant belonging to the Myrtaceae, Carenage, New Caledonia, L. J. Dumbleton, Apr. 8, 1955.

This species resembles *noumeae* in having well developed pore plates associated with the tracheal pores, in having recessed thoracic tracheal pores, and in having rather small glands of uniform size well removed from one another but near the margin. It differs from *noumeae* and all other species in having a greatly expanded, crescent-shaped abdominal tracheal pore plate and in having the caudal setae far removed from the abdominal tracheal pore and posterior pair of glands.

Orchamoplatus plumensis (Dumbleton), new combination (fig. 3, E–G)

Orchamus plumensis Dumbleton, 1956, Roy. Ent. Soc. London Proc. (ser. B) 25(pts. 7–8):132, 138–139, 141, illus.

One of the four available specimens is parasitized.

Mounted specimens differing from *mammaeferus* as described below.

Dorsal surface black, heavily sclerotized. Broadly oval, anterior end narrower than posterior end, widest across abdominal segment 2; 1 mm. long and 0.85 wide.

Margin and submargin: Margin entirely smooth or 1 short broad tooth on one or each side of tracheal pore areas. Anterior marginal setae about 32 μ long, posterior marginal about 44 μ. Tracheal pore area teeth 6 to 9 in number, the majority well separated from one another but 2 sometimes fused; short, stout, the longest 12 μ; 8–12 μ wide; bases of teeth not swollen and not strongly demarked from adjacent derm but pore area somewhat swollen and ridgelike, and differentiated from adjacent derm. Ridges well defined, varying in width. Glands terminating laterad of abdominal tracheal pore area, 37 to 41 in number with 10 to 11 anterior and 26 to 30 posterior to thoracic tracheal pore area on each half of body; twice the width of one apart and

twice the length of one from margin; the majority 12–14 μ long and 10–12 wide but one each side of tracheal pore areas 16–20 μ long and these nearly attaining margin. Submarginal setae close to margin. Ridge not evident proximad of glands.

Dorsal disk: Weakly sculptured. Transverse molting suture with midpoint nearer to thoracoabdominal than to meso-metathoracic suture; broadly curved laterocaudad to first abdominal suture, then recurved and terminating opposite its own midpoint. Intersegmental sutures well defined and some extending into subdorsum. Median length of abdominal segment 7 approximately one-half that of segment 6. Disk pores and porettes small. Two pairs of invaginated pores on cephalic segment. Cephalic setae 32 μ long; first abdominal 32 μ; eighth abdominal 100 μ, contiguous to widest part of vasiform orifice; caudal 80 μ, located on cephalic margin of abdominal tracheal pore area, bases slightly more than the length of a posterior gland apart. Vasiform orifice 96 μ long and 112 wide; about one-fifth its length from posterior suture and two-thirds its length from abdominal tracheal pore area; sunk in a depression in the derm, its sides bounded by a narrow furrow that extends cephalad to the posterior suture and opens into a caudal furrow posterior to orifice; outer wall of orifice sclerotized, but inner wall rather membranous; a lightly sclerotized membrane covering orifice, and opening apparently a narrow transverse line between the eighth abdominal setae. Inside of orifice with the walls convex; broad, longitudinal ridges apparently on inner surface of membrane covering orifice but position of these not positively determined in available specimens; bottom of orifice apparently extending full length of organ. Operculum apparently 48 μ long and wide, completely enclosed in orifice, sclerotized and sculptured by minute pits on anterior portion.

Ventral surface: Abdominal tracheal fold with a few minute spines; presence or absence of other spines not determinable.

Redescribed from four mounted paratypes on an undetermined plant, Plum, New Caledonia, L. J. Dumbleton.

This species is unique in having a strongly modified vasiform orifice, a caudal furrow, a smooth body margin, and in having the tracheal pore area teeth as wide as long and the pore areas ridgelike.

Aleuroplatus (Orchamus) premnae Corbett, 1926, BUL. ENT. RES. 16(pt. 3):272–273, illus.

This species does not have submarginal glands or the other structures that characterize *Orchamoplatus* and should not be placed in this genus. It may be left in *Aleuroplatus* pending the further study of it and related species.

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A Biological Study of the Lawn Armyworm, Spodoptera mauritia (Boisduval), in Hawaii (Lepidoptera: Phalaenidae)[1]

YOSHINORI TANADA[2]

HAWAII AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF HAWAII
HONOLULU, HAWAII

AND

J. W. BEARDSLEY, JR.

EXPERIMENT STATION, H.S.P.A.
HONOLULU, HAWAII

(*Presented at the meeting of December 9, 1957*)

The lawn armyworm, *Spodoptera mauritia* (Boisduval), was first correctly recorded from Hawaii in 1953 (Pemberton, 1955) and within a year (Tanada, 1955) became one of the most serious pests of lawns, particularly those planted with Bermuda grass, *Cynodon dactylon* (L.) Persoon (fig. 1). Although the name *S. mauritia* appears early in Hawaiian literature, it was being used erroneously at that time for the nutgrass armyworm, *Laphygma exempta* (Walker) (see Swezey, 1938). Recently Fletcher (1956) has placed Hawaiian specimens in the subspecies, *Spodoptera mauritia acronyctoides* Guenée, rather than in the nominate subspecies, *S. mauritia mauritia* (Boisduval). He reported the distribution of the former subspecies as the Oriental, Indo-Australian, and Pacific regions.

The present importance of *S. mauritia* and the limited knowledge of its biology in Hawaii have prompted this study. In addition to the laboratory studies, which were conducted both at the Hawaii Agricultural Experiment Station and the Experiment Station of the Hawaiian Sugar Planters' Association, field observations of both authors are included herein.

DESCRIPTION OF STAGES

The descriptions and measurements of the various stages were based on live or freshly killed specimens. Length measurements were made of individuals soon after they had molted. Widths of the larval heads were measured under the binocular stereoscopic microscope. Such head measurements were obtained from molted head capsules except in the case of the last larval instar

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[2] Present address: Laboratory of Insect Pathology, Department of Biological Control, University of California, Berkeley.

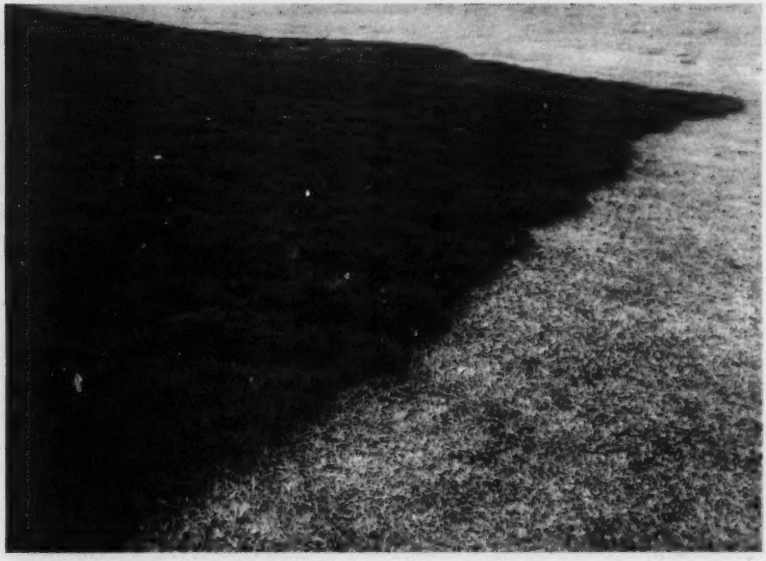

FIG. 1. Portion of a Bermuda grass lawn in the Aina Haina area of Honolulu damaged by the lawn armyworm during January 1956. The sharply defined "front" separates the denuded area at right from the undamaged portion at left.

when they were based on head capsules still attached to the larvae because head capsules discarded before pupation were split open and could not be measured accurately.

Eggs: The eggs are laid together in masses which vary greatly in size, shape, and number of eggs. The egg masses are frequently rather elongate-oval in outline, and are about 10 mm. to 20 mm. long and 5 mm. to 10 mm. wide (fig. 2, A). They consist of from one to five or more irregular layers of eggs. The upper layers usually contain progressively fewer eggs so that the entire egg mass has a somewhat convex appearance. Long, light-brown, hair-like setae from the terminal end of the female's abdomen may cover the egg mass so thickly that individual eggs are not visible. Some masses, presumably those of older females which have depleted their supply of setae, are less heavily covered. The eggs when laid are light tan in color and have a slightly pearly luster. They generally darken to a gray or dark tan before hatching, but in some masses they acquire a pronounced greenish or pinkish cast. Individual eggs are circular in outline and somewhat flattened at the lower pole where they come in contact with the substratum. Their exterior is sculptured with fine longitudinal striations which extend from the micropylar pole to about the equator. Their lower surface is smooth. They measure about 0.5 mm. in diameter and about 0.4 mm. through the polar axis.

Mature larvae: Larvae in the seventh and eighth instars are considered mature (see section on life history), and a thorough description of such larvae is given below as an aid to the identification of caterpillars of this species. The immature instars are considered in less detail.

The mature *S. mauritia* larva is a typical smooth-skinned armyworm (figs. 2, C; 5, A), and attains a length of about 35 mm. to 40 mm. when fully grown. Newly molted seventh-instar larvae averaged 22.88 mm. in length, and head capsules of this stage averaged 2.78 mm. in width. Eighth-instar individuals, when they occurred, averaged 36.55 mm. in length when young, and their head capsules averaged 3.5 mm. in width (table 1).

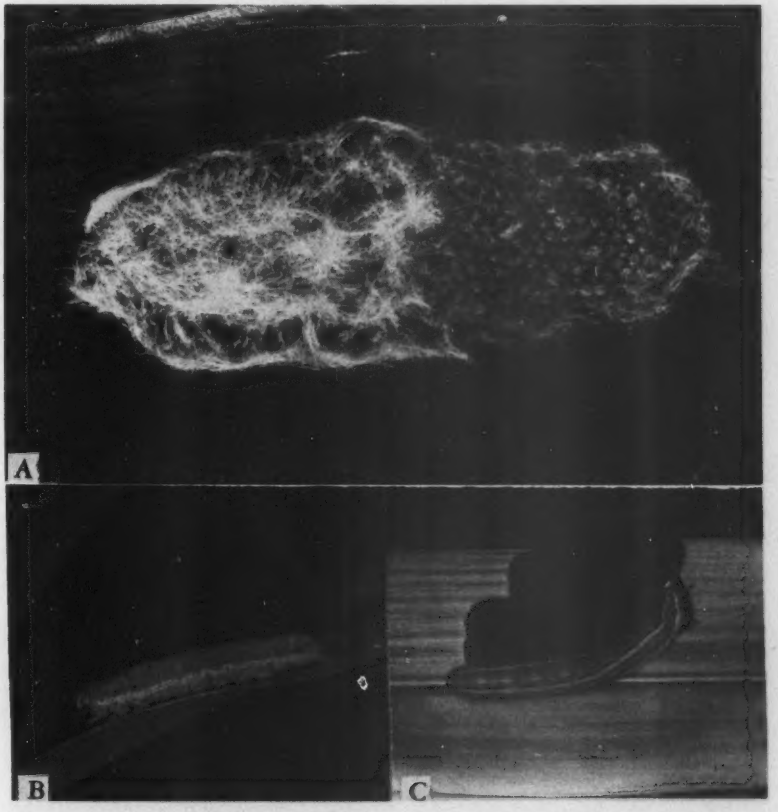

FIG. 2. A, egg mass of *Spodoptera mauritia* on ti leaf (the covering of long setae from the female abdomen has been removed from the right side to show the individual eggs); B, fourth instar larva of *S. maurita* on a grass blade; C, seventh-instar *S. mauritia* larva feeding on sugar cane leaf.

The basic body pattern of the mature larva is quite constant, although there may be considerable variation among individuals in the relative amounts of dark- and light-pigmented areas. The head capsule is predominantly brown and is darkest in a band just laterad of the adfrontal and coronal sutures. The frons is testaceous, and a distinctly pale mark, shaped like an inverted Y, occupies the adfrontal areas on either side and extends along the coronal suture. The regions of the ocelli and genae are irregularly testaceous. The pronotal shield is brownish, with three narrow, pale yellow or white, longitudinal stripes.

On each side of the body a distinct pale subdorsal band, which is about 0.75 mm. wide and continuous with the pale lateral stripe of the pronotal shield, extends the entire length and onto the anal shield. These bands vary in color from almost pure pale yellow to light reddish-brown. A darker, much less distinct, more irregular, and frequently interrupted medio-dorsal band extends posteriorly from the medio-dorsal stripe of the pronotal shield. The darker dorsal area between these bands is predominantly grayish, varying in shade in different individuals. A pair of prominent, elongate, jet-black marks occurs on all body segments except the prothorax and the tenth abdominal, one on each side just mesad of the mesal border of the subdorsal band. These marks vary somewhat in size from specimen to specimen but never coalesce to form a continuous band. Where strongly developed, the marks are shaped approximately like acute triangles and attain their maximum width in the anterior half of the segment which they occupy. On each side, the lateral region of the body ventrad of the subdorsal band and dorsad of the lower edges of the spiracles is occupied by a pair of darkish longitudinal bands, each about 0.75 mm. wide, which are separated by a very fine, often interrupted, pale line. The lower or spiracular band is usually the darker and is generally purplish-brown in color. The upper or supraspiracular band is grayish with a yellow or greenish tinge. In fully fed larvae the upper band tends to darken and lose its greenish cast so that the two bands are more nearly concolorous. Some specimens possess a small black mark on each abdominal segment immediately above the spiracle and just below the fine pale line which separates the spiracular and supraspiracular bands.

A pale yellowish to light reddish-brown subspiracular band, similar to the subdorsal band, is usually discernible on each side. In some specimens the ventral margin of this band may be poorly delineated from the pale venter. The spiracles are black.

Under magnification, the derm of the unsclerotized portions of the body, except the jet-black marks, is seen to consist of a fine reticulate pattern of tiny light and dark marks. In the light bands the light component is pale yellow and the dark component is mostly a light reddish-brown. In the darker bands the dark component is mostly black and the light component white. In preserved specimens the yellow and reddish colors are lost so that the medio-

dorsal band is less evident, and the subspiracular band is often indistinguishable from the pale venter.

The mandibles (fig. 3, C) have five distinct teeth, and their oral faces are without a basal or sub-basal tooth. The frons is slightly longer than broad, and the coronal arm of the epicranial suture is longer than the frontal arms. The adfrontal sutures are confluent well before the occiput, and the length of the coronal suture from the occiput to this juncture is about equal to the length of the frons (fig. 3, B). The anterior prolegs each possess 16 to 19 crotchets arranged in a homoideous uniordinal mesoseries.

The setal pattern of the mature caterpillar is illustrated in figures 3 and 4. Setigerous tubercles, with the exception of IV, V, and VI of the prothorax, and VI of the meso- and metathorax, are not noticeably sclerotized. Seta IIIa of the abdominal segments is represented by a papilla and a very small, fine seta. The eighth abdominal spiracle was found to be from 1.3 to 1.5 times as long dorsoventrally as the seventh.

There are two other species of grass-inhabiting armyworms in Hawaii with which *S. mauritia* caterpillars possibly may be confused. These are the cosmopolitan armyworm, *Pseudaletia unipuncta* (Haworth), and the nutgrass armyworm, *Laphygma exempta* (Walker). Mature *P. unipuncta* caterpillars (fig. 6, A) are less vividly marked than those of *S. mauritia*. The pale subdorsal bands are absent or barely discernible, and the conspicuous black dorsal marks which occur in *S. mauritia* larvae are not present. In *P. unipuncta* a narrow, interrupted, blackish band with a fine white line along its ventral margin lies between the supraspiracular and the subdorsal bands. The mandibles of *P. unipuncta* possess but two obscure teeth, whereas those of *S. mauritia* and *L. exempta* have five distinct teeth. Seta A^1 of the face is mesad of A^2 in *P. unipuncta*, but in *S. mauritia* and *L. exempta* it is laterad of A^2.

The larvae of *L. exempta* vary widely in coloration, much more so than do those of *S. mauritia*. However, the darker forms, which sometimes resemble *S. mauritia* in the possession of a pair of dorsal black marks on each segment, differ in that the spiracular band is much darker and conspicuously narrower than the supraspiracular band (fig. 6, B). Also, the dark forms of *L. exempta* have a conspicuous white spot behind and slightly above the spiracle on abdominal segments I to VIII. Such spots are absent or barely discernible in mature *S. mauritia* larvae, but are more pronounced in fifth- and some sixth-instar individuals. The ratio of the dorsoventral length of the spiracles of the seventh and eighth abdominal segments furnishes a convenient character for the separation of mature larvae of these two species. In 20 specimens of *S. mauritia* which were measured, the eighth abdominal spiracle was 1.3 to 1.5 times as long as the seventh, whereas in 15 specimens of *L. exempta*, the eighth ranged from 1.8 to 2 times as long as the seventh abdominal spiracle.

The structures of the spinneret and labial palpi are used extensively by Crumb (1956) in his classification of the larvae of the Phalaenidae. Although

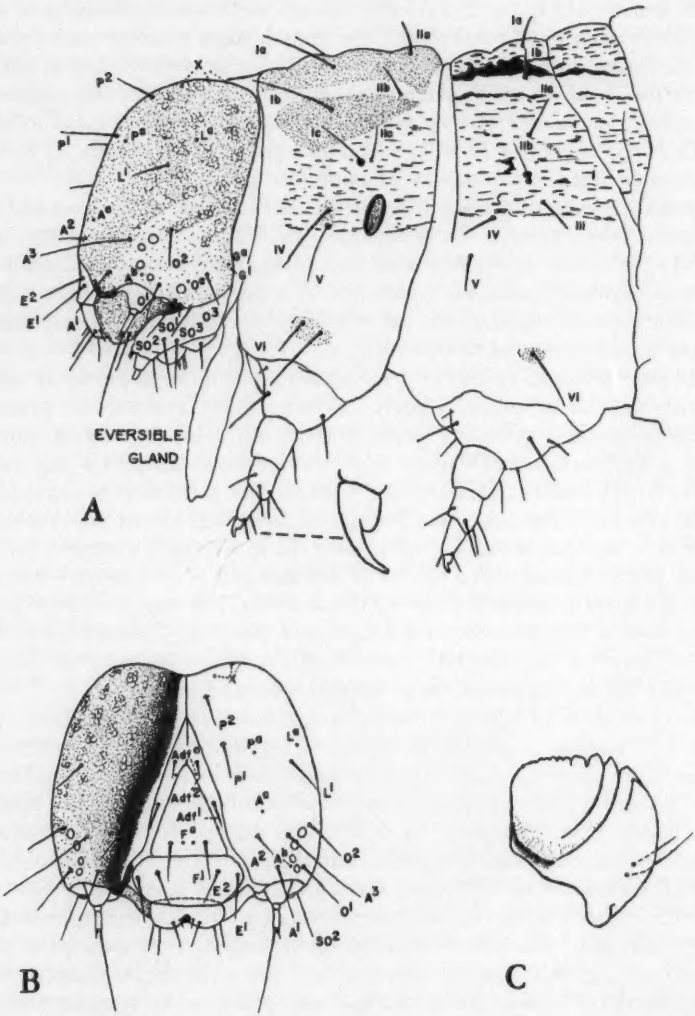

FIG. 3. Mature larva of *S. mauritia*. A, lateral aspect of head, prothorax, and mesothorax; B, frontal aspect of head; C, inner face of left mandible.

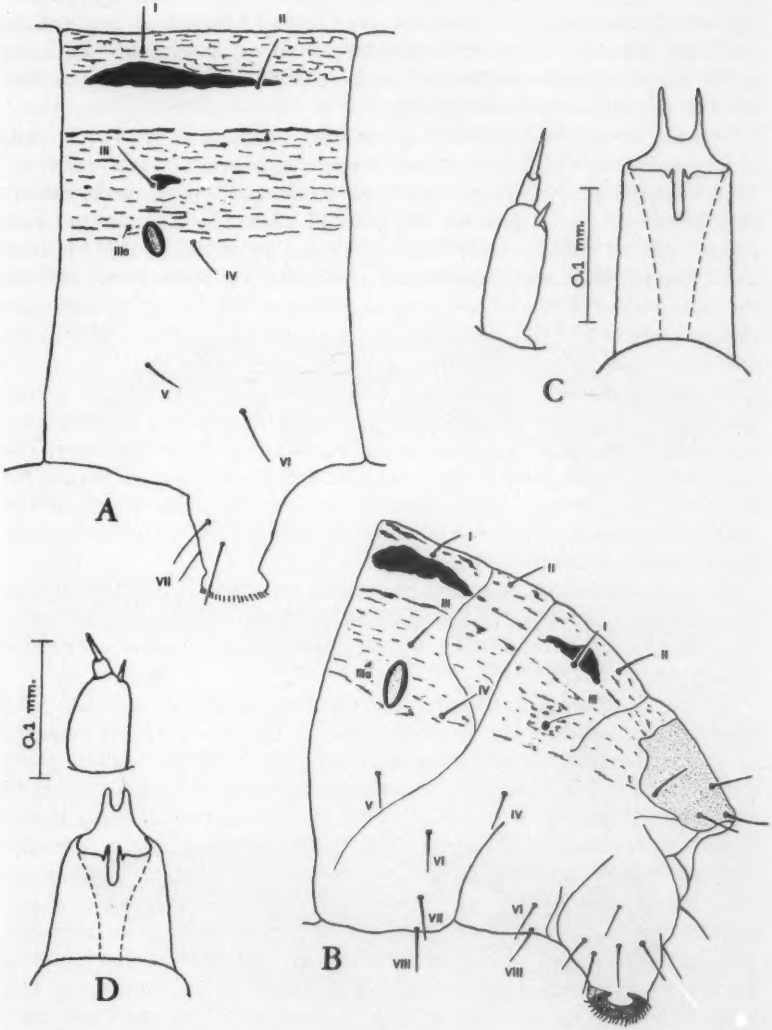

FIG. 4. A, lateral aspect of fourth abdominal segment of mature *S. mauritia* larva; B, lateral aspect of abdominal segments VIII to X; C, spinneret and labial palpus of mature *S. mauritia* larva; D, spinneret and labial palpus of mature *Laphygma exempta* larva.

neither *S. mauritia* nor *L. exempta* is included in Crumb's treatment (which is limited to North American forms), these characters have been figured here (fig. 4, C, D) for comparative purposes. In Crumb's key both of these species run to his "Group 7" of the subfamily Amphipyrinae. *L. exempta* will not run to the genus *Laphygma*, as the third segment of the labial palpus is less than one-half as long as the basal segment.

Immature larvae: The first-instar larvae upon hatching averaged 1.24 mm. in length and the width of their head capsules averaged 0.30 mm. (table 1). Their head capsules, prothoracic and anal shields, and legs are black, and the body setae arise on conspicuous dark pinacula. Soon after feeding, the larvae attain a general greenish body color, and a few white longitudinal lines become discernible. A medio-dorsal line, and a subdorsal line on each side are the most distinct of these. There is also a somewhat less distinct supraspiracular line on each side which is closer to the subdorsal line than this is to the medio-dorsal.

Second-instar larvae, shortly after ecdysis, averaged 3.06 mm. in length, and their head capsules averaged 0.47 mm. in width (table 1). The head capsule, shields, and legs of this instar are largely a pale testaceous color. The dark pinacula at the bases of the body setae are relatively smaller than in the first instar. The medio-dorsal, subdorsal, and supraspiracular white lines of the first stage are apparent, and, in addition, there is usually a relatively wide, white, subspiracular band on each side.

Newly molted third-instar larvae averaged 4.16 mm. in length, and their head capsules averaged 0.69 mm. in width (table 1). Third-instar larvae resemble those of the second instar except that the white subspiracular band is usually more pronounced.

Young fourth-instar larvae averaged 6.41 mm. in length, and their head capsules averaged 0.95 mm. in width (table 1). During the fourth instar the larvae are still predominantly greenish in color (fig. 2, B). The head is usually pale testaceous, but in some more strongly pigmented individuals it may be somewhat darker laterally with a pale frons. The pronotal shield is also slightly darker in some specimens. Three pale longitudinal lines, continuous with the medio-dorsal and the subdorsal lines of the body, are discernible on the pronotal shield in this and subsequent instars. The subdorsal and, particularly, the mediodorsal lines are relatively wider than in previous instars, and the subspiracular band is well developed. Above this is a green spiracular band which is usually slightly darker than the green areas of the dorsum. This is bounded dorsally by a narrow, pale, supraspiracular line. In some specimens, the spiracular band may be entirely light purplish in color; in others, the purplish area is reduced to streaks in various portions of the posterior end of the stripe and sometimes to some of the anterior segments. A short blackish streak is frequently present on the mesothorax along the mesal margins of each of the subdorsal lines. The black pinacula surrounding the body setae

are relatively small and extend very little beyond the margins of the papillae.

Newly molted fifth-instar larvae averaged 8.30 mm. in length, and their head capsules averaged 1.43 mm. in width (table 1). Upon reaching the fifth instar, the larvae acquire the fundamental pattern of stripes and markings characteristic of the mature armyworm. Although some larvae are predominantly green, others have the brown or purplish-brown color of the later larval instars. A pair of narrow black marks is usually present on each segment behind the prothorax along the mesal border of the subdorsal bands. The prothoracic and anal shields are dark brown to blackish. The three pale stripes of the prothoracic shield are well defined. In darker individuals, the area mesad of the subdorsal band is noticeably darker than the area ventrad and is often brown or purplish-brown. The supraspiracular band is noticeably

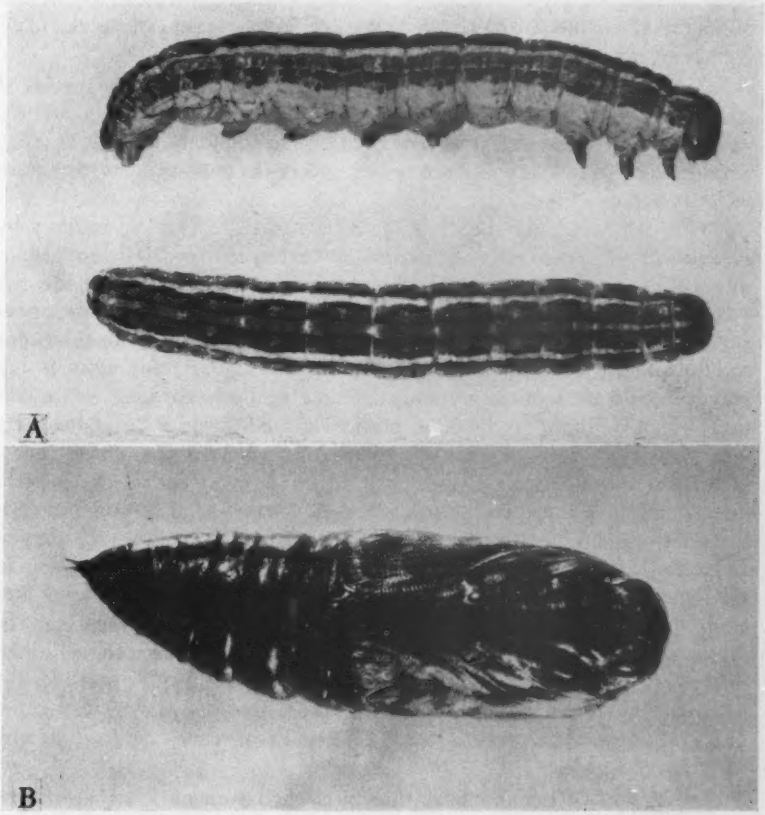

FIG. 5. A, lateral and dorsal aspects of mature *S. mauritia* larva; B, ventral aspect of *S. mauritia* pupa.

lighter and more greenish than is the spiracular band, and an interrupted fine white line separating these bands is usually discernible. Many specimens possess small white spots in the spiracular band, one of which is located on each segment posterior to and slightly dorsad of the spiracle. These spots are also evident in some sixth-instar larvae but are absent or hardly noticeable in seventh- and eighth-instar larvae. Body setae of this and subsequent instars lack dark pinacula. The coloration of the head is similar to that of the mature caterpillar.

Young sixth-instar larvae averaged 16.75 mm. in length, and head capsules of this stage averaged 2.05 mm. in width (table 1). In the sixth instar the dorsal black markings are more strongly developed than in the preceding stage, and the general color is grayish- or purplish-brown. The spiracular band is darker than the supraspiracular in this and in young seventh-instar larvae; but in most older mature larvae the greenish color of the supraspiracular band fades, and the bands often appear nearly concolorous.

Pupae: The pupa (fig. 5, B) is of the same general form as other species of armyworms and cutworms. It is reddish-brown in color when fully hardened, hairless, and rather smooth. Its average length was found to be about 16 mm., ranging from 14 to 18 mm. in the twenty specimens measured. Its maximum width is about 4.5 mm.

Adults: Both sexes of the adult moth have been redescribed recently by Fletcher (1956). There is a consistent and well-marked sexual dichromism in this species. The male (fig. 7, B), which is the more vividly marked sex, has a conspicuous white diagonal mark in the anterior median area of the upper surface of the forewing, between the whitish or buff-colored orbicular spot and the roughly reniform dark spot. In the female (fig. 7, A) this region is dull grayish-brown and is not appreciably different from adjacent areas. Pale markings, which are found in the distal portion of the forewings of the male, are more strongly developed than those in the forewings of the female. These include an area of white, suffused with brown, near the apex of the wing; a fine, white, subterminal fascia; and an incomplete white fascia which extends from near the distal end of the diagonal white mark to the posterior margin. In general, the brownish areas of the forewings are darker in the male than in the female. The hind wings of both sexes are pale except for a darker area along the costal margin anterior to vein Rs, and along the outer margin. The undersurface of the forewing is mostly dull grayish. In some specimens, particularly males, the proximal area of the undersurface may be considerably paler, and some also show a streak of dull reddish along the costal margin. The wing expanse varied from 34 mm. to 40 mm. in females and from 30 mm. to 37 mm. in males.

The dorsum of the thorax is thickly clothed with elongate grayish to reddish-brown scales. The legs, particularly the coxae, femora, and tibiae of the fore pair, are clothed with brushes of similarly colored, slender, elongate,

hair-like scales. These brushes are much more strongly developed in the male sex. The vestiture of the abdomen is usually slightly lighter in color than that of the thorax.

In Hawaii, *S. mauritia* adults most closely resemble those of *Laphygma exempta*. *L. exempta* adults average slightly smaller (wing span 28 mm. to 35 mm.) than those of *S. mauritia* and may be distinguished by minor differences in the pattern of the forewings. In *L. exempta* the amount of variation among individuals of the same sex is much greater than which has been en-

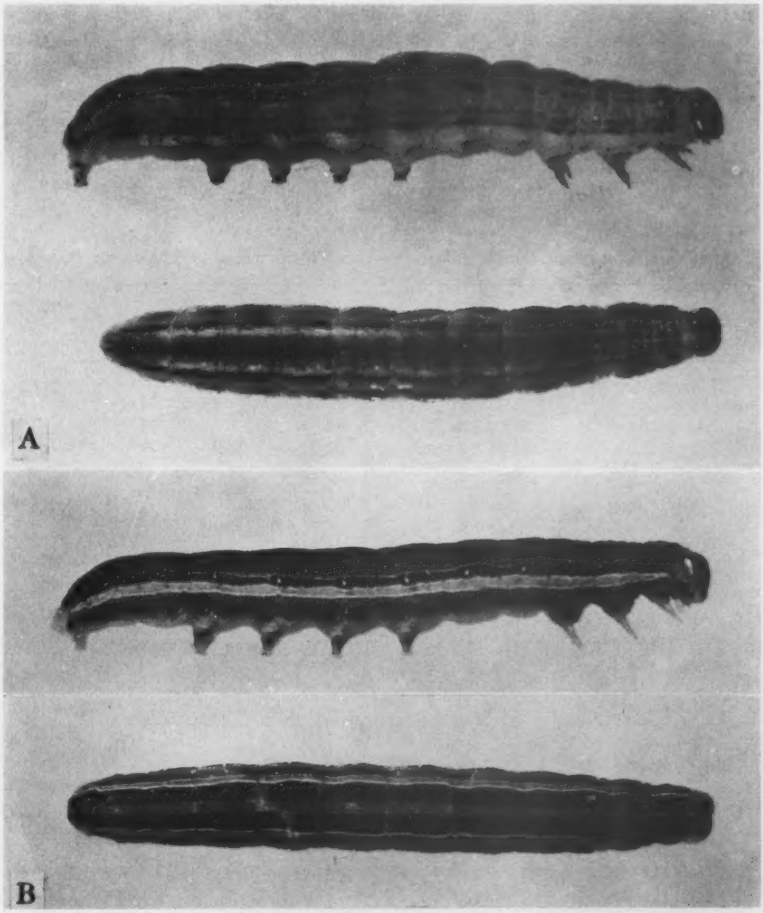

FIG. 6. A, lateral and dorsal aspects of mature *Pseudaletia unipuncta* larva; B, lateral and dorsal aspects of mature *Laphygma exempta* larva.

TABLE 1. Measurements of head-capsule width and larval length in the larval instars of *S. mauritia* (Boisduval)

INSTAR	WIDTH OF HEAD CAPSULES			LENGTH OF LARVAE*		
	No. measured	Mean (mm.)	Standard Deviation (mm.)	No. measured	Mean (mm.)	Standard Deviation (mm.)
I.....	40	0.30	0.010	20	1.24	0.159
II.....	40	0.47	0.024	20	3.06	0.352
III.....	40	0.69	0.038	20	4.16	0.433
IV.....	40	0.95	0.067	20	6.41	0.884
V.....	40	1.43	0.170	20	8.30	0.933
VI.....	40	2.05	0.224	20	16.75	2.900
VII.....	29	2.78	0.279	18	22.88	1.914
VIII....	19	3.5	0.16	20	36.55	3.649

* Larvae measured shortly after ecdysis.

TABLE 2. Duration of the various immature stages for individuals of *S. mauritia* (Boisduval)

DURATION (Days)	EGG*	1ST INS.	2ND INS.	3RD INS.	4TH INS.	5TH INS.	6TH INS.	7TH INS.	8TH INS.	PUPA
1.....			1	11						
2.....			35	31	13	17	13	1		
3.....	23	20	21	12	42	38	30	11		
4.....	4	33			1		14	12	1	
5.....		3						3	6	
6.....								14	6	
7.....								11	7	
8.....								1		2
9.....										6
10.....									1	8
11.....										8
12.....										9
13.....										2
14.....										1
15.....										
16.....										1
Total Number Indiv.....	27	56	57	54	56	55	57	53	21	37
Mean Duration (Days)..	3.2	3.7	2.4	2.0	2.8	2.7	3.0	5.0	6.1	10.9

* Number of egg masses rather than individual eggs.

countered so far in *S. mauritia*. The general coloration of the forewing of *L. exempta* males is usually somewhat lighter than that of *S. mauritia* males. In the forewing of the former species there is a more extensive pale apical area which extends diagonally some distance basad of the pale subterminal fascia. Also, most *L. exempta* males possess a fairly definite pale mark near the base of the forewing, which in *S. mauritia* is represented by a brownish area only slightly lighter than its surroundings. The anteromedian reniform spot is dark and well defined in all *S. mauritia* males but is frequently obscure in

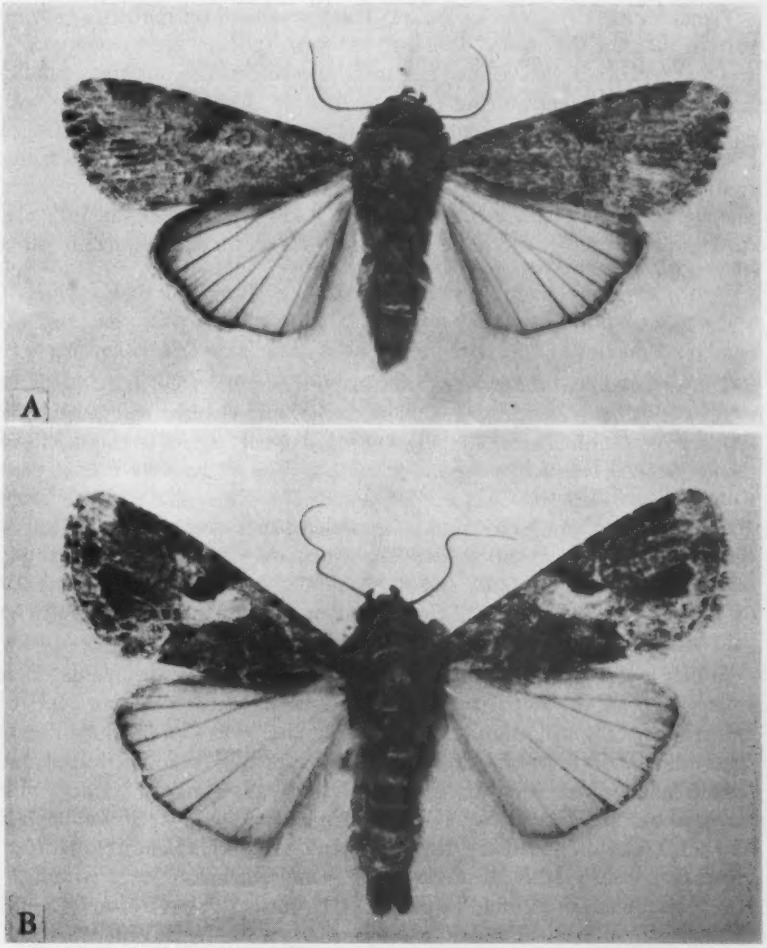

FIG. 7. A, adult female *S. mauritia*, dorsal aspect; B, adult male *S. mauritia*, dorsal aspect.

those of *L. exempta*. In *L. exempta* males the light orbicular spot usually is a trifle larger and more elongate, and the area between it and the reniform spot is usually not entirely pale, as it is in *S. mauritia*. *S. mauritia* males have a patch of dark brown just basad of the pale subterminal fascia and slightly behind the median longitudinal axis of the wing. In *L. exempta* this area is paler and usually contains two or three well-defined, slender, dark, elongate, pyramid-shaped marks. Such marks are usually absent, or never more than faintly suggested in *S. mauritia* males. The brushes of scales on the forelegs are much less noticeably developed in *L. exempta* males.

Females of the two species are less easily separated on the basis of wing pattern than are the males. The dark reniform spot on the forewing of *S. mauritia* females is well defined but in *L. exempta* females this spot is much less definite, frequently being indistinguishable. Two fine, irregular, dark, anterior-to-posterior fasciae are usually fairly well developed in *L. exempta* females—one about one-third, and the other about two-thirds the distance from base to apex. In *S. mauritia* females these fasciae, particularly the basal one, are less definite and more interrupted. As in the male sex, the orbicular mark is slightly larger and more elongate in *L. exempta* females than in those of *S. mauritia*.

Life History and Habits

The armyworms immediately after hatching were reared individually in sterilized, half-pint, cardboard containers that were covered with a half of a sterilized petri dish. These caterpillars were fed mainly tender young shoots of napier grass, *Pennisetum purpureum* Schumach. The adults were kept in one-gallon, wide-mouth glass jars and fed sugar water placed in a syracuse watch glass containing absorbent cotton. Crumpled paper toweling was placed in the jars to serve as oviposition sites. The temperature in the laboratory ranged mainly between 72°F (22°C) and 85°F (29°C) with occasional extremes of 68°F (20°C) and 86°F (32°C). The relative humidity was ordinarily 56 to 85 per cent with extremes of 50 to 92 per cent.

Mating and oviposition: Inasmuch as the adults may mate within a day after emerging from the pupal case, the newly emerged females were kept together with adult males during the first night after emergence and then separated individually into half-pint containers. The preoviposition period of nine females under observation that produced fertile eggs averaged 3.7 days with extremes of 1 and 7 days. Two additional females with preoviposition periods of 9 and 11 days, respectively, laid only sterile eggs. This indicates that mating may normally stimulate oviposition. One female laid eggs within 24 hours, but this record should be confirmed by further observations. In South India, Anantanarayanan and Ramakrishna Ayyar (1937) recorded the preoviposition period as 3 to 6 days.

In the laboratory, the gravid females usually began to oviposit shortly after dusk. Most of the eggs were deposited before midnight, but some were also laid during the early morning hours before daybreak. Once oviposition had started, the females would continue to lay eggs even in the presence of a bright light. During oviposition the moth would remain fairly rigid except for a slight quivering of the antennae. The tip of the abdomen moved continuously and stopped only for an instant to eject an egg. Then, moving over the still moist egg the moth spread over it the long, hair-like setae which readily became detached from the tip of the abdomen. The eggs usually were laid close to each other but not necessarily in a systematic pattern, as the female sometimes skipped places for several eggs in a row and returned later to fill the gaps. Upon completion of egg-laying, the female remained standing above the egg mass for about half a minute wiping off more setae from her abdomen onto the eggs.

The rate of egg-laying in the case of one female was 25 eggs during the first four minutes, and after 30 minutes the egg mass contained 273 eggs. The number of egg masses laid by five females averaged 8.6 masses per female. Oviposition began on the first day after emergence and continued to the eighth day. The maximum number of masses deposited by one female during a single night was three. These females had been kept with males only during the first night after emergence and thereafter were caged individually.

In nature, females were observed to deposit their eggs mainly on the foliage of shrubs and small trees, and on leaves of the lower limbs of taller trees. They rarely laid their eggs on the blades of the lawn grasses which are attacked by the larvae, and the few masses that were observed on grass blades were usually small with relatively few eggs. Cherian and Anantanarayanan (1937) reported that egg masses deposited on the leaves of rice plants in India were small (15 to 20 eggs per mass) as compared to those laid in the laboratory. Normal-sized egg masses were sometimes found on the leaves of stools of sugar cane in Honolulu, but such cane was not fed upon by the caterpillars.

Surface texture of foliage had little or no effect on its attractiveness for oviposition. Just as many egg masses were laid on leaves with smooth surfaces as on those with rough or hairy surfaces. Leaf size, except for very tiny or narrow leaves (less than ¼ inch in width), also was not an important factor in the choice of oviposition sites. Among the more common garden plants, mango, palms, Chinese banyan, breadfruit, loquat, and pandanus were frequently favored as oviposition sites by *S. mauritia* females.

The wooden and concrete walls and eaves of houses and other buildings were often utilized as oviposition sites. *S. mauritia* is strongly phototropic, and often large concentrations of egg masses were found on buildings and foliage near an outdoor light, or in the vicinity of a window from which light emerged most of the night. The concentration of egg masses in the vicinity

of such lights is probably an important factor affecting the density and distribution of larval populations in residential areas. There was an indication that more eggs were laid on walls on the leeward sides of buildings than on those on the windward sides. Eggs were sometimes laid on laundry left out overnight.

Individual egg masses of *S. mauritia* were found to contain as many as 1372 eggs, and the mean number of eggs in 16 masses was 709. Anantanarayanan and Ramakrishna Ayyar (1937) reported that, in India, egg masses usually contained from 50 to 500 eggs, and the maximum number of eggs laid by one female in the laboratory was 2750. A range of 200 to 300 eggs per mass was reported by Otanes (1925); 200 to 400 by Commun (1932); 100 to 200 by Smith (1933); and 200 to 300 by Otanes and Karganilla (1940).

The eggs required an average of 3.2 days to hatch under laboratory conditions (table 2). Hutson (1920) observed that the egg stage ranged between 7 to 10 days; Commun (1932) and Smith (1933) observed that it averaged 7 days; Cherian and Anantanarayanan (1937) as 3 to 5 days; and Anantanarayanan and Ramakrishna Ayyar (1937) as 4 to 5 days; Otanes and Karganilla (1940) reported it as 2 to 4 days.

Larval stages: The duration of the first larval stadium averaged 3.7 days in the laboratory (table 2). Hutson (1920) recorded this stadium as 10 days, and Smith (1933) as 2 days. The second stadium lasted an average of 2.4 days, as compared to 4 days reported by Smith (1933). The third stadium averaged 2.0 days, the fourth 2.8 days, and the fifth 2.7 days (table 2). Smith (1933) reported 3, 1, and 3 days respectively for these stadia. The sixth stadium averaged 3.0 days, the seventh 5.0 days, and the eighth, when it occurred, averaged 6.1 days (table 2).

According to the published records, the larvae of *S. mauritia* apparently do not have a constant number of larval instars. Otanes (1925) found that the larvae molted six times (and therefore must have passed through six instars). Smith (1933) reported five larval stages. In South India, Anantanarayanan and Ramakrishna Ayyar (1937) observed that the larvae underwent five molts in the majority of cases but occasionally had six or seven molts.

In our laboratory studies, some larvae pupated after the seventh instar, but in others an additional molt occurred. Although observations were rather limited, the occurrence of the additional instar seemed to be correlated with the duration of the seventh stadium (note the bimodal nature of the duration of the seventh stadium in the figures of table 2). When the larvae required 5 to 8 days to complete the seventh instar, they tended to pupate directly; but when they were in this instar only 2 to 4 days they molted into the additional eighth instar. Thus, the occurrence of an eighth molt did not necessarily increase the total larval period to any great extent. Anantanarayanan and Ramakrishna Ayyar (1937) also reported that additional molts did not appreciably prolong the larval period of *S. mauritia*. In Hawaii the additional eighth molt

in *S. mauritia* larvae occurred independently of the sex of the larvae, and the cause of its occurrence was not determined.

The entire larval period averaged 27.7 days under laboratory conditions in Hawaii. A period of about a month was given for the larval stages by Hutson (1920); 18 days by Jarvis (1922); from 14 to 23 days by Otanes (1925) and Otanes and Karganilla (1940); from 3 to 5 weeks by Rao (1926), Dammerman (1929), and Cherian and Anantanarayanan (1937); and from 21 to 32 days by Anantanarayanan and Ramakrishna Ayyar (1937).

Only the first- to fifth-instar larvae were seen feeding during the day. The older larvae are largely nocturnal and ordinarily spend the daylight hours hidden in the loose soil or humus below the grass; exposing themselves during the day only when migrating to new feeding areas. Such migrations result when heavy populations of caterpillars denude the lawn of all suitable grass. On several occasions caterpillars have been observed crossing gardens and sidewalks apparently in search of food.

Severe damage to lawns by *S. mauritia* larvae is frequently characterized by a sharply defined "front" between the undamaged and denuded areas of grass (fig. 1). Such fronts tend to move forward a foot or so each night when large populations of mature or nearly mature caterpillars are present in the grass. The damaged area commonly spreads outward from shrubs, trees, sides of buildings, etc., that have been utilized as oviposition sites by the female moths.

No cannibalism was observed among the larvae in the field or in the laboratory even under conditions of crowding and food shortage. Smith (1933), however, reported that crowding caused cannibalism.

Pupal stage: Pupation occurs within a loosely formed cocoon of dirt, plant material, and larval webbing. The pupa is usually found in the soil or in organic debris at the base of grass turf. The duration of the pupal stage averaged 10.9 days in the laboratory (table 2). Ballard (1921) reported the length of the pupal stage as 10 days, and Anantanarayanan and Ramakrishna Ayyar (1937) reported it as 5 to 10 days.

Adult longevity: Fifteen newly emerged female moths which were kept individually in half-pint containers and fed sugar water lived an average of 10.6 days, with extremes of 9 and 14 days. The longevity of the three males studied averaged 10.3 days under the same conditions.

Host Range and Host Preference

Inasmuch as the recorded host range of *Spodoptera mauritia* is rather extensive, there is a possibility that the two subspecies of *S. mauritia* which were distinguished by Fletcher (1956) may have somewhat different host preferences. It is also possible that some authors have confused *S. mauritia* larvae with other caterpillars of similar appearance, such as those of *Prodenia litura* (Fabricius). *S. mauritia* has been reported from various countries as a pest of a number of grasses including rice (Ballard, 1921; Anantanarayanan and Rama-

krishna Ayyar, 1937; Commun, 1932; etc.), sugar cane (Jarvis, 1922; Dammerman, 1929), young maize (Dammerman, 1929; Otanes and Karganilla, 1940), barley (Fletcher, 1920), millet (Maxwell-Lefroy, 1909; Fletcher, 1920), wheat (Fletcher, 1920), Bermuda grass (Maxwell-Lefroy, 1909), *Pennisetum typhoideum* Rich. (cumbu) (Rao, 1956), *Eleusine coracana* Gaert. (ragi) (Rao, 1956), *Paspalum dilatatum* Poir. (Smith, 1933), *Paspalum scrobiculatum* L. (Fletcher, 1920), *Panicum setigerum* (P. Beauv.) and *Agropyron repens* (L.) P. Beauv. (Anonymous, 1941), and unspecified grasses (Maxwell-Lefroy, 1909; Dammerman, 1929; Lever, 1946). Besides grasses, *S. mauritia* is known to feed on the sedge *Fimbristylis tenera* Roemer and Schultes (Rao, 1926) and has been reported damaging coconut foliage in Ceylon (Jepson, 1924), cowpea in India (Fletcher, 1920), tobacco in Mauritius (Corbett, 1926; Edward, 1927; Commun, 1932), and crucifers and *Vigna catiang* Endl. in Tonkin (Commun, 1932).

As damage by *S. mauritia* in Hawaii has so far been limited to lawns composed almost entirely of Bermuda grass, an attempt was made to obtain some information concerning its host range and possible host preference. Tests of two types were conducted: (1) starvation tests to determine the ability of larvae to survive on various grasses, sedges, and a few other plants; and (2) host preference tests to determine if larvae would exercise a choice between acceptable food plants.

Starvation Tests: In one series of tests, about 100 recently hatched first-instar larvae were confined in large battery jars containing the food plant to be tested. Testing was confined to the most tender growth of the host plant; and fresh host material was provided every two or three days. In every test, control larvae were fed Bermuda grass. After about 10 days the live larvae in each jar were counted. Tests of each host were repeated at least three times.

In the second series of tests, about 25 larvae in their fifth to early seventh instar, which had been reared on Bermuda grass, were placed in jars with the various test plants. Counts were made after all the surviving larvae had pupated. The control larvae were fed Bermuda grass until pupation. The hosts tested were mostly common lawn grasses and lawn weeds found in and around Honolulu, but a few crop plants were also included. These tests were also replicated three times.

Of the hosts tested the following proved acceptable to both first-instar and later-instar larvae: sugar cane seedlings (two weeks old), *Eleusine indica* (L.) Gaertner (wiregrass), *Stenotephrum secundatum* (Walt.) Ktze. (buffalo grass), *Zoisia matrella* (L.) Merr. (Manila grass), *Paspalum dilatatum* Poir. (Dallis grass), *Chaetochloa verticillata* (L.) Scribner (bristly foxtail), *Digitaria henryi* Rendle (crabgrass), *Cyperus gracilis* R. Br. (McCoy grass), *Cyperus rotundus* L. (nutgrass), and *Cyperus kyllingia* Endl. (kyllinga). Survival on these hosts ranged from 72 to 100 per cent in the various tests, with no material difference between Bermuda grass and the test hosts.

Survival of first-instar larvae on leaves of young corn plants (about one foot high) was 26, 68, and 82 per cent in three tests, while survival in the controls was 66, 82, and 100 per cent respectively. Older larvae developed without difficulty on young corn, and survival was nearly 100 per cent. In five tests with the following two hosts, *Zoisia tenuifolia* Willd. (velvet grass) and leaves of sugar cane grown from cuttings, survival of first-instar larvae was low (0 to 5 per cent with cane leaves, and 0 to 22 per cent on velvet grass). When older larvae were tested on these two hosts survival approached 100 per cent in all trials, although the time required for the larvae to complete development was several days to a week or more longer than in the controls.

In three trials with young fronds of the Macarthur palm, *Actinophloeus macarthuri* (Wendl.) Becc., all the first-instar larvae succumbed after 3 or 4 days, although some attempted to feed at the tips of leaflets. Later-instar larvae were able to feed on the palm leaflets, and as many as 60 per cent in one test were able to complete development to pupae. However, these required 7 to 10 days longer than the controls. In tests with the foliage of *Lycopersicon esculentum* Mill. (tomato), *Nicotiana tabacum* L. (tobacco), *Cordyline terminalis* (L.) Kunth. (ti), and *Zingiber* sp. (ginger), none of either the first-instar or later-instar larvae survived.

Although only a small number of food plants were tested, the above results indicate that in Hawaii the host range of *S. mauritia* is limited largely to grasses and sedges. Apparently almost any grass can serve as a host, but in the case of tough or hard foliage, as with sugar cane grown from cuttings (the usual method of field propagation) and velvet grass, there may be a very high mortality of first-instar larvae when they are restricted to such hosts. Velvet grass was the only one of the common lawn grasses tested which showed some resistance to attack by *S. mauritia*. Corn seems to be less suitable as a host for the young larvae than most of the smaller grasses. It also appears that the development of later-instar larvae is somewhat prolonged when these are forced to feed on the tougher hosts. Anantanarayanan and Ramakrishna Ayyar (1937) reported that *S. mauritia* preferred the tender leaves of paddy rice 4 to 10 days old and ignored leaves which were over a month old.

Host preference: On the island of Oahu, damage by *S. mauritia* has been confined very largely to Bermuda grass lawns. Lawn weeds such as wire grass and nut-grass which often occur within armyworm-damaged lawns usually show little evidence of feeding. Such observations have led to the speculation that *S. mauritia* larvae are selective when presented with a choice of acceptable grasses. To test this hypothesis, first-instar larvae were confined in battery jars containing two bunches of fresh grass leaves approximately equal in quantity: one of Bermuda grass and one of the other test grass. Fresh bunches of both grasses were added daily, and after 5 or 6 days the food material was carefully removed, the number of larvae on each host counted, and evidence of feeding noted. Because of the limited time available, only two grasses were

tested against Bermuda grass in this manner. These were buffalo grass, a tough, thick-leaved grass commonly grown for lawns and which has not yet been seriously attacked by *S. mauritia*, and wire grass, a common and persistent lawn weed. Tests with each of these grasses were repeated three times.

In the tests with buffalo grass, the larvae showed a definite preference for Bermuda grass. In the three trials, only 2.6, 5.0, and 10.0 per cent, respectively, of the larvae were on buffalo grass at the conclusion of the tests and there was very little evidence of feeding on the buffalo grass leaves. In the tests with wire grass, there were 56.9, 51.6, and 29.5 per cent, respectively, of the larvae on the grass at the conclusion of the tests. Here, only the last test indicated a preference for Bermuda grass over wire grass by the armyworm. However, in the first two tests, both the wire grass and the Bermuda grass were taken from lush, unmowed, well-watered plots, and consequently the leaves were all very tender. In the last test the wire grass was taken from a lawn where it was a prostrate and tough-leaved form. These results indicate that probably the tenderness of the leaves rather than the species of grass may be the more important factor determining the choice of grass fed upon by *S. mauritia* larvae. Smith (1933) also reported that *S. mauritia* was partial to certain grasses, but he was able to raise the larvae successfully in the laboratory on a number of grasses that were ignored by larvae in the field.

Natural Enemies

Microorganisms: A polyhedrosis virus attacking *S. mauritia* was first reported in Hawaii by Bianchi (1956). That the so-called bacterial disease reported by Anantanarayanan and Ramakrishna Ayyar (1937) may have been caused by a polyhedrosis virus is suggested by the similarity in symptomatology. According to Tanada and Beardsley (1957), the polyhedrosis virus found by Bianchi may have entered Hawaii together with its host. In the field, the virus has been observed both in young (second- to fourth-instar) larvae and older larvae. In several outbreaks of *S. mauritia* on lawns in Hawaii, a large percentage of the larvae were killed by virus epizootics. Accordingly, this virus may have some promise in the microbial control of the armyworm.

Spores of a microsporidian were found in eggs of *S. mauritia* collected in the field at Waialae-Kahala, Honolulu. These eggs were apparently killed by the protozoan, which was tentatively identified as *Nosema* sp. The microsporidian is highly infectious and can be readily transmitted by feeding contaminated foliage to the larvae. Some infected larvae survived to maturity, and the adults were found to contain microsporidian spores. The effect of this microsporidian in the natural control of *S. mauritia* in the field has not been evaluated.

Many dead eggs of *S. mauritia* were observed covered with a dark-green fungus. The fungus appeared more commonly in the wet areas of the valleys than in the drier areas near the coast. Although in a few preliminary attempts,

it was not possible to transmit the fungus to healthy eggs and larvae, further tests should be conducted to prove conclusively whether it is a true pathogen or merely a saprophyte developing on eggs killed by other causes.

An entomogenous fungus attacking the larvae was reported by Smith (1933). In Ceylon, Hutson (1920) reported a fungus and a bacterial disease on *S. mauritia*.

Predators: Inasmuch as observations of predators attacking *S. mauritia* in Hawaii were made incidentally while collecting material for other purposes, the predator list discussed here is undoubtedly incomplete.

The egg stage of *S. mauritia* is subject to attack by several predators, but, except in the special circumstances cited below, these appeared to be of minor importance in the reduction of armyworm populations. Two species of ants were found attacking and destroying healthy eggs on foliage. *Monomorium floricola* Jordan was associated with *S. mauritia* eggs at several places in the Aina Haina-Wailupe Circle section of Honolulu. These minute ants were observed to enter egg masses through apparently ant-made holes in the top or at the sides of the overlying mat of setae, where they appeared to have crushed the contained eggs and removed their contents. At one location, these ants at times completely destroyed many egg masses on a *Pandanus* tree that was regularly and heavily utilized for oviposition by *S. mauritia* females. The number of egg masses consumed by ants on this tree was once estimated to be about one-third of the total viable egg masses present. In a few instances the big-headed ant, *Pheidole megacephala* (Fabricius), was observed attacking *S. mauritia* eggs on mango foliage in a manner similar to that of *Monomorium*.

Coccinellids occasionally were found feeding on *S. mauritia* eggs; but it appeared that such predation was largely incidental, for in such cases they were associated with infestations of scales, mealybugs, or aphids upon which these beetles normally feed. Of the three species of coccinellids involved, both adults and larvae of *Orcus chalybeus* (Boisduval) were seen feeding on eggs, while only the adults of *Cryptolaemus montrouzieri* Mulsant and *Scymnus roepkei* Fluiter were so observed.

In the course of this study, the only predators of *S. mauritia* larvae observed in Hawaii were the giant toad, *Bufo marinus* (L.), and the Indian mynah bird, *Acridotheres tristis* (L.). However, it seems probable that some insects (such as wasps, lacewing larvae, and ants) and other invertebrate predators may also attack caterpillars in the grass. In Ceylon, predatory bugs (Hemiptera) and a beetle, *Cicindela sexpunctata* Fabricius, are reported to feed on the caterpillars (Hutson, 1920). In South Africa, Dick (1943) observed that the Argentine ant destroyed the prepupae and pupae of *S. mauritia*.

Mynah birds have frequently been observed converging on lawns where the caterpillars of *S. mauritia* are abundant, and Swezey (1909) considered the mynah bird a valuable enemy of armyworms and cutworms in Hawaii. In Ceylon (Henry, 1917) and in India (Ballard, 1921) mynah birds have also been

reported feeding on *S. mauritia* larvae. Other birds such as ducks, storks, cranes, herons, egrets, chickens, and crows have occasionally been reported to be effective in the control of this armyworm in various countries (Henry, 1917; Hutson, 1920; Ballard, 1921; Otanes, 1925; Y. R. Rao, 1926; Commun, 1932; Ramakrishna Ayyar,1 933; Anantanarayanan and Ramakrishna Ayyar, 1937).

Our observations on the giant toad indicate that it may be an important factor limiting *S. mauritia* populations, since the nocturnal feeding habits of the toad coincide with those of the mature armyworm. Out of a total of 26 toad feces found on two lawns in the Kailua section of Oahu following an armyworm outbreak in the spring of 1956, 25 were found to contain head capsules of *S. mauritia* larvae. On a lawn badly infested with armyworms in the Aina Haina area of Honolulu, one large fecal mass was found to contain 138 armyworm head capsules, which probably represents the total number of armyworms consumed by that particular toad during one or two nights. It is worth noting, though not necessarily indicative of a direct correlation, that nearly all the serious armyworm damage in the Aina Haina-Wailupe Circle area has occurred in the drier areas where toads are scarce or absent. In Fiji, *Bufo marinus* has also been reported feeding on *S. mauritia* larvae (Lever, 1939).

Parasites: The insect parasites which have been reared from *S. mauritia* have all been known previously in Hawaii as enemies of other species of Lepidoptera, particularly of various species of armyworm and cutworms. For detailed information relating to armyworm parasites in Hawaii, the reader is referred to papers on the subject by Pemberton (1948) and Bianchi (1944).

Two species of egg parasites which attack *S. mauritia* occur rather commonly on the island of Oahu. The scelionid, *Telenomus nawai* Ashmead, has been bred from *S. mauritia* egg masses collected in the Aina Haina and Waialae-Kahala areas of Honolulu (Beardsley, 1955). A survey of egg parasitization made over a period of about a year showed that at some stations (*i.e.* upper Aina Haina) anywhere from 60 to 95 per cent of the egg masses in a sample contained eggs parasitized by *T. nawai*. At stations in another locality about one-half mile distant (*i.e.* Wailupe Circle) only an occasional sample contained one or two parasitized egg masses. The ecological factors responsible for this difference in parasitization at the two localities have not been determined.

Usually only a portion of the eggs in a given mass was parasitized by *T. nawai*, and the remaining unparasitized eggs (numbering a few to nearly all in a given mass) gave rise to caterpillars. Occasional egg masses were found which were 100 per cent parasitized, but the majority of those which yielded parasites were from 20 to 80 per cent destroyed. The heavy covering of setae as well as the several layers of eggs in an egg mass seem to hinder the parasite so that it is less effective than on the thinner, less heavily covered egg masses of *Laphygma exempta*. It was also observed both in the field and in the labo-

ratory that adults of *T. nawai*, although fully formed, frequently failed to emerge from parasitized eggs.

The second species of egg parasite found parasitizing *S. mauritia* eggs in Hawaii was the trichogrammatid, *Trichogramma minutum* Riley. Usually, this wasp was less plentiful in egg samples than was *T. nawai*, and, like the latter, it rarely parasitized all the eggs in a given mass. It was not uncommon for an egg mass collected in the field to yield adults of both *T. nawai* and *T. minutum*, as well as some caterpillars.

Three species of braconid wasps so far have been reared from *S. mauritia* larvae in Hawaii. Caterpillars parasitized by these wasps are killed before they are more than about half grown, and consequently such caterpillars do not attain the older, more destructive stages.

The braconid egg-larval parasite, *Chelonus texanus* (Cresson), was first reported attacking *S. mauritia* in Hawaii by Van Zwaluwenburg (1955). This species has frequently been seen ovipositing in *S. mauritia* eggs in the field, and adults have been bred from field-collected larvae. This wasp was introduced into Hawaii from Texas in 1942 to combat *Laphygma exempta* (see Bianchi, 1942). In *S. mauritia*, the parasite grub emerges when the host larva is in the fifth or sixth instar, and feeds externally for a day or so until the host remains are reduced to a head capsule and a bit of skin. Pupation takes place in a cocoon in ground litter. The life cycle from oviposition to emergence of the adult wasp required about 30 days when reared on *S. mauritia* in the laboratory.

Several egg masses on which *C. texanus* females were seen ovipositing in the field were collected and held in the laboratory. From 14 to 60 per cent of the caterpillars which issued from these egg masses and which survived until the fifth instar eventually were killed by the parasite. However, when young caterpillars (in second, third, and fourth instars) were collected at two stations in the Aina Haina-Wailupe Circle area during a period of 6 months, never more than 2 or 3 per cent of them were parasitized. It appears that *C. texanus* may be of minor importance in the natural control of *S. mauritia*.

Apanteles marginiventris (Cresson) was also first observed by Van Zwaluwenberg (1955) on *S. mauritia*. It was likewise introduced from Texas for the control of *L. exempta*, and appears to be one of the most important natural enemies of *S. mauritia* in Hawaii. It was the parasite most frequently reared from early-instar *S. mauritia* larvae collected in the field.

Females of *A. marginiventris* lay their eggs in first-instar armyworm larvae, and on sunny mornings they may frequently be seen searching for suitable hosts among grass blades in armyworm-infested lawns. The fully fed parasite grub emerges from the host caterpillar when the latter is in the fourth instar, and forms a white cocoon, usually on a grass blade. Where lawns are mowed frequently and the cuttings removed, a fairly large proportion of the cocoons may thereby be destroyed. The life cycle of this parasite from oviposition to

adult emergence required 12 to 18 days when reared on *S. mauritia* larvae in the laboratory. Individual collections of second- to fourth-instar armyworms made at two stations in the Aina Haina-Wailupe Circle area of Honolulu during 1956 and 1957 were from less than 10 to more than 80 per cent parasitized by *A. marginiventris*, with an overall average of 31.6 per cent at one station, and 32.8 per cent at the other. A hyperparasite, *Eupteromalus* sp., was once reared from field-collected cocoons of *A. marginiventris*.

Like the two preceding species, *Meteorus laphygmae* Viereck was purposely introduced from Texas in 1942. It has been reared from *S. mauritia* larvae on several occasions but appears to be less important than *A. marginiventris*. Females of *M. laphygmae* oviposit in young *S. mauritia* larvae (probably only those in the first and second instars), and when mature the parasite grub leaves the host, which is then usually in the fourth or fifth instar. The brownish *M. laphygmae* cocoons, each attached to a grass blade by a long silken thread, may sometimes be found in lawns infested by *S. mauritia*.

Three species of tachinid flies have been found parasitizing *S. mauritia* larvae in Hawaii. *Chaetogaedia monticola* (Bigot) and *Achaetoneura archippivora* (Williston) were reported previously (Beardsley, 1955), and *Eucelatoria armigera* (Coquillett) is now recorded for the first time. When parasitized by one of these flies, the host caterpillar is killed in the pupal or last larval stage, generally after it has completed feeding. Therefore, such caterpillars, even though parasitized, may contribute materially to lawn damage before they succumb. When plentiful, these flies probably constitute an important factor limiting the size of armyworm populations. However, no attempt was made to evaluate the relative importance of the flies as natural control factors.

A number of parasites have been recorded from *S. mauritia* in other parts of the world. In Ceylon, Hutson (1920) reported two species of small parasitic wasps, and two species of braconid parasites, one a *Macrocentrus* species, were reported from Fiji (Lever, 1946). Swezey (1940) reared the ichneumonid, *Echthromorpha conopleura* Krieger, from the pupae in Guam, and on one occasion he found 22 per cent of the pupae parasitized. In New Guinea, a braconid, *Microdus* sp., was reared from *S. mauritia* larvae and apparently exercised noticeable control (Anonymous, 1941). In South India, *Charops dominans* (Walker) (an ichneumonid); *Apanteles ruficus* Haliday, and *Chelonus* sp. (braconids); and *Euplectrus uplexiae* Rohwer (an eulophid) were reared from *S. mauritia* by Anantanarayanan and Ramakrishna Ayyar (1937). Ballard (1921) reported *Chelonus carbonator* Marshall and a *Chelonus* sp. as parasites in India. The tachinid parasites, *Cyphocera varia* Fabricius, *Sturmia bimaculata* Hartig, *Tachina fallax* (Meigen), *Pseudogonia cinerascens* Rondani, and *Actia aegyptia* Villeneuve have been recorded from *S. mauritia* in South India (Ballard, 1921; Rao, 1926; Anantanarayanan and Ramakrishna Ayyar, 1937). Tachinids have also been reported as parasites of *S. mauritia* in South Africa (Dick, 1943), in the Philippines (Goco, 1921; Otanes, 1925) and various parts of

South East Asia (Thompson, 1947). In using Thompson's list of parasites it should be remembered that Hawaiian records included therein are not valid as the host upon which they were based was actually *Laphygma exempta*, misidentified as *S. mauritia*.

Summary

A biological study of the lawn armyworm, *Spodoptera mauritia* (Boisduval), was conducted under laboratory conditions in Hawaii. Field observations of some aspects of its biology are also included in the study. The stages in the life history of the armyworm are described in detail, and the results of life history studies are presented.

The entire life cycle from egg to adult required approximately 42 days. Each female moth laid an average of 8.6 egg masses in the laboratory. In nature, most of the eggs were deposited on the foliage of shrubs and trees, and on eaves and walls of buildings. Very few eggs were laid on the leaves of the grasses which serve as food for the larvae. Completion of the larval stages required about 28 days, and the pupal stage about 11 days. Most of the larvae studied passed through seven larval instars, but some went through an additional, or eighth, larval instar. This extra instar occurred in larvae of both sexes.

In Hawaii, most of the damage caused by this armyworm has been in lawns planted with Bermuda grass, *Cynodon dactylon* (L.) Persoon. Starvation and host preference tests indicated that the host range of the larva is limited largely to grasses and sedges. The larvae selected tender over tough foliage and, when forced to feed only on tough foliage they took longer to complete their development.

The natural enemies of *S. mauritia* that were observed in the field in Hawaii are discussed. Among these, a polyhedrosis virus, *Bufo marinus* (L.) (the giant toad), *Telenomus nawai* Ashmead (a scelionid egg parasite), *Apanteles marginiventris* (Cresson) (a braconid parasite of the young larvae), and three species of tachinid flies appeared to be the most important biological control agents.

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A New Genus of Reduviidae from the Hawaiian Islands (Hemiptera)

ROBERT L. USINGER

UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA

(*Presented at the meeting of December 9, 1957*)

The only endemic Reduviidae thus far described from the Hawaiian Islands are species of Emesinae of the world-wide genera *Ploiaria* and *Empicoris* and one unique genus *Nesidiolestes*. In the present paper another endemic genus is described. Like *Nesidiolestes* it is brachypterous and hence difficult to place in its proper systematic position. In fact, the new genus bridges the gap, at least as regards key characters, between the Emesinae and Saicinae.

The first specimen of the new genus was found glued to a card with several specimens of *Empicoris* in the collection of the British Museum (Nat. Hist.). The second specimen was located in the collection of the B. P. Bishop Museum. It was labelled in the handwriting of O. H. Swezey "N. G. near Nesidiolestes." Both specimens were taken by R. C. L. Perkins at 5000 feet on Haleakala, Maui, one in 1894 and the other in 1896.

Saicella, new genus

Body form short, with the sides of abdomen dilated and upper surface subflattened. Surface with a short, appressed tomentum on head and scattered short hairs or pubescent patches elsewhere.

Head three-fourths as wide as long, with a deep bisinuate transverse impression between eyes. Disk without spines or tubercles but with antennae inserted on anterolateral prominences above base of rostrum. Eyes small, one-fourth as wide as interocular space, as measured from above; subglobose in outline with coarse individual facets. Rostrum with first segment longest, its sides subparallel, second segment inflated, third segment slender and tapering; proportions of segments one to three as 30:13:12; ratio of width of first segment to width of second, 7::9; first segment with two pairs of long, stiff spines directed obliquely upward in addition to numerous finer hairs and bristles; second segment with one pair of long, stiff spines. Under surface of head with a pair of prominent spines near base of rostrum and three pairs of very prominent spines standing out from the mass of shorter hairs and bristles below the eyes. Antennae long, slender, and without erect hairs, the first segment longer than head and thorax; proportion of segments one to three (fourth and possibly part of third broken off) 44:42:10.

Prothorax strongly constricted near basal fourth, widened anteriorly and with coxal cavities opening obliquely forward and downward. Pronotum concave behind head, not produced laterally beyond level of anterior acetabula, the ratio of front to hind lobe lengths 25::10, the ratio of widths, 40::25; disk deeply longitudinally impressed at middle. Hind lobe of pronotum transverse, raised into a low, rounded elevation at middle in front of shallowly concave hind margin.

Mesonotum a little longer than hind lobe of pronotum, 13::10, with a stout spine arising from middle, the spine slightly longer than mesonotum and feebly bent backward. Metanotum a little longer than mesonotum, 15::13, with a slightly shorter and more slender spine. Hemelytral pads two and one-half times as long as greatest width, slightly exceeding hind margin of metanotum.

Legs long, the front coxae a little longer than depth of prothorax on an oblique line from margins of front acetabula to convex hind margin of front lobe of pronotum, 40:38; each coxa with a row of fine bristles alternating with four or five stout spines on inner face and with two very prominent spines at base immediately in front of acetabulum. Fore trochanters with fine hairs but no prominent spines. Proportions of coxa, trochanter, femur, tibia, and tarsus of fore leg 40:15:72:56:15. Femur moderately incrassate and curved, the inner face with about 9 prominent spines nearly but not quite as long as thickness of femur, with fine erect hairs between. Outer edge of front femur with five very prominent spiniferous tubercles, the combined length of spine and tubercle subequal to thickness of femur. Distad of these spines (apical fourth) with a row of very short, tooth-like spines. Tibia narrowed at apical third and then again thickened toward apex, with several prominent bristles on inner face at basal third and a dense mat of short white hairs on inner face apically. Front tarsus apparently two segmented, the first segment half as long as second. Tarsus bearing two very small symmetrical claws.

Middle and hind coxae smooth, bulbous, separated by a distance about equal to the width of a coxa, the meso- and metasterna rather evenly rounded. Proportion of front, middle and hind femora 25:42:56. Middle and hind femora distinctly curved, exceeded in length by tibiae which are roughly one-fourth longer. Middle and hind tarsi very small, with three subequal segments and two minute claws.

Abdomen approximately three times as wide at middle as at extreme base, the connexival margins slightly concave on flaring basal portion, convex in general outline at middle and posteriorly but with the connexival angles feebly prominent so that the margins of each segment appear slightly concave. Basal tergite with a broad raised area which is convex behind, tomentose anteriorly and glabrous posteriorly and occupies about half of the tergite. Hind margin of sixth visible tergite bisinuate. "Pygidial" plate behind this

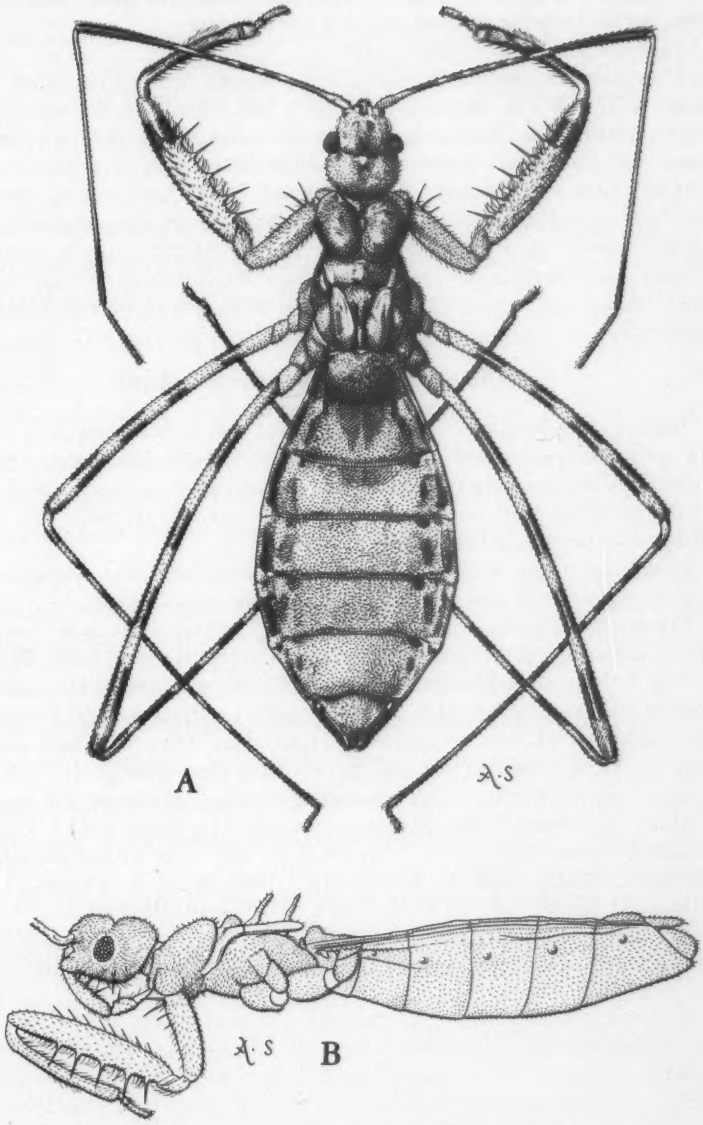

Fig. 1. *Saicella smithi*, n. sp., female paratype. A, dorsal view; B, side view.

subtriangular with broad apex. Ventral surface with prominent, raised spiracles, the hind margin of basal segment not angulate.

Type species: *Saicella smithi*, n. sp.

The systematic position of *Saicella* is an enigma. On key characters (McAtee, W. L. and J. R. Malloch, Proc. U. S. Nat. Mus., Vol. 67, Art. 1, p. 2, 1925) it runs to the Saicinae except that the anterior coxal cavities open forward and downward. The short tarsi differ from those of Saicinae which typically have a subflattened apical segment. Unfortunately wing venation and male genital characters, both of which might be decisive, are not known. In the absence of other evidence the typically Saicine rostrum and head bristles could be taken as definitive evidence of relationship; though ventral head bristles are known in a few genera of Emesinae (*Tinna*, *Orthunga*, *Collartida*).

Saicella smithi, new species (fig. 1, A, B)

Head .75 mm. long by .5 mm. wide, covered with a white tomentum except for glabrous median area including ill-defined longitudinal sulcus. Raised portions of anterior lobe of pronotum glabrous. Meso- and metathorax with white appressed hairs on disks and laterad of hemelytral pads. The latter glabrous or with only faint, minute hairs.

Abdominal terga shallowly but distinctly punctured and faintly, transversely rugose, with two shallow depressed lines submarginally.

Color reddish brown with the head paler, ochraceous, the acetabula pale, the abdominal terga mottled with pale yellow except for black base; legs pale yellow with an ill-defined brown ring subbasally and subapically on front femora and four distinct dark rings on middle and hind femora. Fore tibiae more broadly darkened, the middle and hind tibiae with a half dozen distinct dark bands on basal half and less distinct dark areas distally.

Size: length 4.7 mm., width (prothorax) .7 mm., (abdomen) 1.5 mm.

Holotype, female, Haleakala, Maui, 5000 feet, May, 1896, R. C. L. Perkins, British Museum (Nat. Hist.), "Sandwich Is. 1913–323." Paratype, female, Haleakala, Maui, 5000 ft., March–April, 1894, R. C. L. Perkins, B. P. Bishop Museum.

Named for Mr. Arthur Smith, the gifted artist who has added so much to the appearance and scientific value of this and other entomological publications.

New Hawaiian Records for the Year 1957

Species marked with an asterisk were reported from the Hawaiian Islands for the first time in 1957 on the dates recorded in the text. Those not so marked were observed here earlier but have only now been identified.

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PROCEEDINGS

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